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9600bps

TAPR 9600bps Modem Manual

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INTRODUCTION

The TAPR 9600 bps modem is an accessory for packet experimenters developing higher-speed rf links. This is a new design from TAPR and was tested for several months prior to this release. This new design is derived from the pioneering efforts of Steve Goode, K9NG and James Miller, G3RUH. TAPR extends its gratitude to those individuals who assisted in the design and release of this modem and Gary Hauge, N4CHV, Lyle Johnson, WA7GXD and Bob Nielsen, W6SWE for this documentation.

These notes are intended to aid the builder of the TAPR 9600 bps modem kit. Refer to the additional documentation (included with this kit) for a detailed circuit description, operational hints and operating principles. This kit includes all parts and components necessary to fully populate the PC board and mating connectors. It does **NOT** include the case, front panel, rear panel power connector, knobs, fuses, etc.

Access to test equipment, including a voltmeter and oscilloscope is required to align the modem and verify its performance. An ohm meter would be very helpful in identifying some resistor values.

This manual provides sufficient information for the advanced experimenter to build, align and operate the 9600 bps modem.

Please check the shipment for any possible errata sheet(s) and / or additions / corrections to instructions provided in this manual.

NOTE: Please read the Construction notes prior to starting assembly.

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The Tucson Amateur Packet Radio (TAPR) 9600 bps Modem Kit was made possible by the pioneering efforts of Steve Goode, K9NG and James Miller, G3RUH and the active participation of a number of Amateur Radio operators and organizations worldwide. While the following list is by no means complete, TAPR wishes to acknowledge their contribution to this effort.

Individuals:
Chuck Green, N0ADI
Eric Gustafson, N7CL
Lyle Johnson, WA7GXD

...and the builders of the first run kits whose feedback made this version of the manual possible.

Kit Builders:
Mike Curtis, WD6EHR
Jack Davis, WA4EJR
Chuck Green, N0ADI
Gary Hauge, N4CHV
Lyle Johnson, WA7GXD
Bob Nielsen, W6SWE

PARTS LIST

This parts list is organized by quantity and part type. Please verify that all parts are present, checking the space provided. You may wish to take this opportunity to sort the parts into a compartmented container, such as an egg carton or muffin tin.

Resistors (1 / 4 w, 5% Carbon Film):

( )	(1)	10 Ω	R6 (brown-black-black-gold)
( )	(1)	100 Ω	R1 (brown-black-brown-gold)
( )	(1)	330 Ω	R23 (orange-orange-brown-gold)
( )	(5)	470 Ω	R2, R14, R19, R20, R24 (yellow-violet-brown-gold)
( )	(2)	1K Ω	R3, R15 (brown-black-red-gold)
( )	(2)	2.2K Ω	R26, R27 (red-red-red-gold)
( )	(6)	10K Ω	R4, R5, R18, R32, R32, R34 (brown-black-orange-gold)
( )	(1)	33K Ω	R25 (orange-orange-orange-gold)
( )	(1)	68K Ω	R12 (blue-grey-orange-gold)
( )	(2)	100K Ω	R13,R28 (brown-black-yellow-gold)
( )	(2)	220K Ω	R17, R22 (red-red-yellow-gold)
( )	(1)	300K Ω	R29 (orange-black-yellow-gold)

Resistors (1 / 4 w, 1%, Metal Film)

( )	(1)	12.1K Ω	R10 (1212) or (brown-red-brown-red-white)
( )	(2)	23.7K Ω	R8, R9 (2372) or (red-orange-violet-red-white)
( )	(2)	4.75K Ω	R30, R31 (4751) or (yellow-violet-green-brown-white)

Resistor (Network - 10 pin)

( )	(2)	10K Ω	(103)	RP1, RP2

Resistor, (Trimpot, Single-Turn)

( )	(2)	10K Ω	(103)	R11, R21

Diodes

( )	(2)	1N4148	D2, D6
( )	(3)	LED	D3, D4, D5

Capacitors, Ceramic Monolithic, Z5U

( )	(23)	0.1 uF (104)	C7, C9, C11, C12, C18, C21, C25, U7, U8, U9, U10, U11, U12, U13, U14, U15, U16, U17, U18, U19, U20, U21, U22

Capacitors, Ceramic Monolithic, X7R

( )	(4)	0.001 uF (102)		C1, C2, C3, C4

Capacitors, Ceramic Monolithic, COG

( )	(2)	100 pF (101)	C5, C6
( )	(1)	330 pF (331)	C23
( )	(1)	560 pF (561)	C13
( )	(3)	2200 pF (222)	C15, C16, C26
( )	(1)	2700 pF (272)	C27

Capacitors, Electrolytic, Radial Lead (POLARIZED)

( )	(1)	1 uF (105)	C24
( )	(6)	10 uF (106)	C10, C14, C17, C28, C29, C30
( )	(1)	100 uF (107)	C22

IC Sockets

( )	(2)	08 pin	U4, U5
( )	(8)	14 pin	U7, U8, U9, U10, U11, U19, U21, U22
( )	(2)	16 pin	U12, U20
( )	(4)	20 pin	U13, U14, U16, U18
( )	(2)	28 pin	U15, U17

Transistor

( )	(1)	VN10KM	Q1

Connectors

( )	(4)	2-pin Male Header	JP2, JP3, JP5, JP6
( )	(1)	2-pin Shell	
( )	(2)	2-pin Shunt	
( )	(1)	3-pin Male Header	JP4
( )	(1)	5-pin Right Angle Male Header	P1
( )	(1)	5-pin Shell	
( )	(1)	20-pin Male Header	P2
( )	(1)	26-pin Male Header	P3
( )	(1)	20-pin Female Header	P3
( )	(7)	Pins for Shells	

Integrated Circuits

Note: Do not handle chips at this time.

( )	(1)	16V8 or 18CV8	U13
( )	(1)	16V8 or 18CV8	U14
( )	(1)	27C64, STATE 2.00	U15
( )	(1)	27C64, TX9600 1.00	U17
( )	(2)	CD4006B	U8, U10
( )	(1)	74HC14	U19
( )	(2)	74HC74 or 74HCT74	U7, U9
( )	(1)	74HC86 or 74HCT86	U11
( )	(1)	74HC393 or 74HCT393	U21
( )	(2)	74HC574 or 74HCT574	U16, U18
( )	(1)	74HC4538	U12
( )	(1)	AD7523	U20
( )	(1)	LM393	U4
( )	(1)	LM7805	U23 (REGULATOR)
( )	(1)	TL082	U5
( )	(1)	TL084	U22

Miscellaneous

( ) (1) PC Board, 9600 Modem Rev 1
( ) (1) Assembly Manual (This Document)

NOTE: Shaded Parts are contained in the modem options only. These parts should be ignored if building without the clock option or bit regen option. These are not needed with all kits.

9600bps Modem Clock Option:

( )	(1)	0.1 uF	U6	(104)
( )	(2)	22 pF	C19, C20	(220 or 22J)
( )	(1)	10M Ω	R16	(brown-black-blue-gold)
( )	(1)	16-pin socket	U6	
( )	(1)	74HC4060	U6	
( )	(1)	Crystal	Y1	(4.9152 MHz)

9600bps Modem Bit Regenerator Option

( )	(1)	100K ohm	R7	(brown-black-yellow-gold)
( )	(4)	0.1 uF	(104)	C8, U1, U2, U3
( )	(1)	14-pin socket		U3
( )	(1)	16-pin socket		U2
( )	(1)	20-pin socket		U1
( )	(1)	1N4148		D1
( )	(1)	16V8 or 18CV8		U1
( )	(1)	74HC14		U3
( )	(1)	CD40105B		U2

CONSTRUCTION NOTES:

********** CAUTION **********

It is recommended that when assembling the TAPR 9600 bps modem kit, that you use a very fine pointed soldering tip on an iron of relatively low wattage (25 watts maximum, 15 watts is ideal). Due to the proximity of some of the traces on the PC board, solder bridges are a very distinct possibility. A low wattage soldering iron, fine pointed tip, clean rosin core solder (small size) is the order of the day. Following these points could eliminate several hours of trouble-shooting (or worse). This is good practice when working on any kit.

The accompanying component placement drawing shows the placement of all parts on the circuit board. Pay particularly close attention to:

1) U1, U2, U3, and U6 are not included with the basic modem kit. These are options available from TAPR.

2) When mounting the Electrolytic Capacitors note that laying them down flat against the board (as outlined) will help provide the required space if the modem is to be mounted into a TNC.

3) Identifying the pins on headers P2 and P3. Looking at the modem board from the top of the board you will find pin-1 at the lower right hand position on the connectors (the square pad on the connector). There is a silkscreen dot near this pin.

4) Some resistor values may seem unclear as to color and value. Be very sure of value prior to installation. Access to an ohm meter will be very helpful.

5) Save the clipped leads from the resistors and capacitors as some of these will be used to fabricate test lead points.

6) **Read this entire document prior to starting construction of your kit. There are several final configurations for the 9600 bps modem (depending on which type of TNC you have) and some parts may or may not require installation for your specific configuration.**

CONSTRUCTION

Check the PC Board and verify that the exposed, tinned pads are clean and shiny. If they are not, scrub the board LIGHTLY with a household cleanser (such as "AJAX" or "COMET") and rinse with clean water, then dry with a clean soft towel.

( ) PC board clean

Refer to the layout diagram in Figure 1 for clarification of parts placement. Figure 1 is also attached as a full size diagram at the end of the manual.

NOTE: Shaded Parts are contained in the modem options only. These parts should be ignored if building without the clock option or bit regen option. These are not needed with all kits.

IC Sockets

NOTE: The IC sockets are polarized, with the end nearest pin 1 marked with a notch, beveled corner or numeral 1 embossed in the body of the socket.

( )	U4	08 pin IC socket
( )	U5	08 pin IC socket
( )	U7	14 pin IC socket
( )	U8	14 pin IC socket
( )	U9	14 pin IC socket
( )	U10	14 pin IC socket
( )	U11	14 pin IC socket
( )	U12	16 pin IC socket
( )	U13	20 pin IC socket
( )	U14	20 pin IC socket
( )	U15	28 pin IC socket
( )	U16	20 pin IC socket
( )	U17	28 pin IC socket
( )	U18	20 pin IC socket
( )	U19	14 pin IC socket
( )	U20	16 pin IC socket
( )	U21	14 pin IC socket
( )	U22	14 pin IC socket

Bit Regen Option

( )	U1	20 pin IC socket
( )	U2	16 pin IC socket
( )	U3	14 pin IC socket

Clock Option

( )	U6	16 pin IC socket

Resistors

Resistor leads are on 0.5" centers. A lead-bending jig may be used to help ensure best appearance of the completed kit. The resistors mount flat against the PC board.

( )	R1	100 ohm	brown-black-brown-gold
( )	R2	470 ohm	yellow-violet-brown-gold
( )	R3	1K ohm	brown-black-red-gold
( )	R4	10K ohm	brown-black-orange-gold
( )	R5	10K ohm	brown-black-orange-gold
( )	R6	10 ohm	brown-black-black-gold

( ) Solder and clip twelve (12).

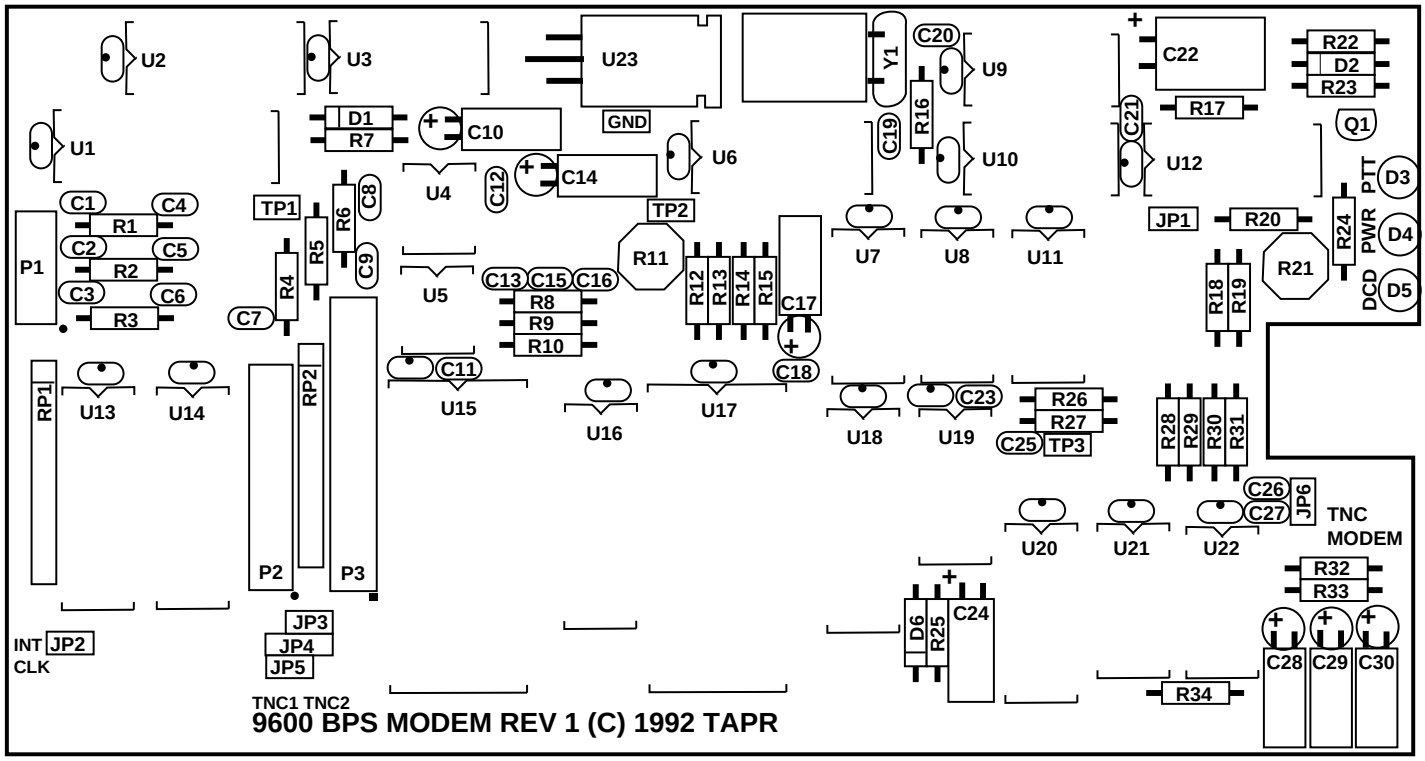


Figure 1 - Component Layout

( ) R8 23.7K ohm 1%
2372 or red-orange-violet-red-white
( ) R9 23.7K ohm 1%
2372 or red-orange-violet-red-white
( ) R10 12.1K ohm 1%
1212 or brown-red-brown-red-white

( ) Solder and clip six (6) leads.

( )	R12	68K ohm	blue-grey-orange-gold
( )	R13	100K ohm	brown-black-yellow-gold
( )	R14	470 ohm	yellow-violet-brown-gold
( )	R15	1K ohm	brown-black-red-gold

( ) Solder and clip eight (8) leads.

( )	R17	220K ohm	red-red-yellow-gold
( )	R18	10K ohm	brown-black-orange-gold
( )	R19	470 ohm	yellow-violet-brown-gold

NOTE: If you intend to use the modem inside a TNC 2 and wish to use the DCD LED on the TNC to indicate the DCD status of the 9600 modem, DO NOT install R20.

( )	R20	470 ohm	yellow-violet-brown-gold
( )	R22	220K ohm	red-red-yellow-gold
( )	R23	330 ohm	orange-orange-brown-gold

NOTE: If you intend to use the modem inside a TNC 2 and wish to use the PTT LED on the TNC to indicate the PTT status of the 9600 modem, DO NOT install R24.

( )	R24	470 ohm	yellow-violet-brown-gold

( ) Solder and clip ten (10), twelve (12), fourteen (14).

( )	R25	33K ohm	orange-orange-orange-gold
( )	R26	2.2K ohm	red-red-red-gold
( )	R27	2.2K ohm	red-red-red-gold
( )	R34	10K ohm	brown-black-orange-gold

( ) Solder and clip six (8) leads.

( )	R28	100K ohm	brown-black-yellow-gold
( )	R29	300K ohm	orange-black-yellow-gold
( )	R30	4.75K ohm 1%	
		4751 or yellow-violet-green-brown-white	
( )	R31	4.75K ohm 1%	
		4751 or yellow-violet-green-brown-white	

( ) Solder and clip eight (8) leads.

( )	R32	10K ohm	brown-black-orange-gold
( )	R33	10K ohm	brown-black-orange-gold

( ) Solder and clip four (4) leads.

Bit Regen Option

( )	R7	100K ohm	brown-black-yellow-gold

Clock Option

( )	R16	10M ohm	brown-black-blue-gold

Resistor Networks

The next parts are resistor SIP networks. These are **polarized** parts; the end with the dot or stripe goes into the square pad. When installing SIPs, tack solder the end pins, verify placement against the PCB, then solder the remaining pins. Finally, re-solder the two end pins.

( )	RP1	10K ohm SIP	(103)
( )	RP2	10K ohm SIP	(103)

Trimpots

Some models of trimpots have leads that "snap" into the board. In any case, be sure the trimpot leads extend approximately 1 mm below the board before soldering.

( )	R11	10K ohm TRIM	(103)
( )	R21	10K ohm TRIM	(103)

( ) Check placement of components & solder in place.

You should have no remaining resistors (except possibly R20 and R24).

( ) No unexpected resistors left over.

Capacitors

NOTE: Capacitor locations with no "C" designator, but with filled-in dot in the part outline, are bypass capacitor locations. These will be installed later.

Electrolytic capacitors are polarized. The positive lead goes in the hole location on the board marked with a "+". The PCB pad is square for the positive lead. The capacitors themselves usually have the negative lead marked, so be careful!

Install the following capacitors:

( )	C1	0.001 uF	(102)
( )	C2	0.001 uF	(102)
( )	C3	0.001 uF	(102)
( )	C4	0.001 uF	(102)
( )	C5	100 pF	(101)
( )	C6	100 pF	(101)
( )	C7	0.1 uF	(104)
( )	C9	0.1 uF	(104)

( ) Solder and clip sixteen (16) leads.

( ) C10 10 uF (106) Polarized
( ) C11 0.1 uF (104)
( ) C12 0.1 uF (104)
( ) C13 560 pF (561)
( ) C14 10 uF (106) Polarized
( ) C15 2200 pF (222)
( ) C16 2200 pF (222)

( ) Solder and clip fourteen (14) leads.

( ) C17 10 uF (106) Polarized
( ) C18 0.1 uF (104)
( ) C21 0.1 uF (104)
The marking for C21 is obscured by the socket for U9 (See Fig. 1).
( ) C22 100 uF (107) Polarized

( ) Solder and clip eight (8) leads.

( ) C24 1 uF (105) Polarized
( ) C23 330 pF (331)
( ) C25 0.1 uF (104)
( ) C26 2200 pF (222)
( ) C27 2700 pF (272)
( ) C28 10 uF (106) Polarized
( ) C29 10 uF (106) Polarized
( ) C30 10 uF (106) Polarized

( ) Solder and clip sixteen (16) leads.

Bypass Capacitors
Bypass capacitors are installed in the capacitor outlines marked with a filled in dots. They have no "C" designator.
( ) U7 0.1 uF (104)
( ) U8 0.1 uF (104)
( ) U9 0.1 uF (104)
( ) U10 0.1 uF (104)
( ) U11 0.1 uF (104)
( ) U12 0.1 uF (104)

( ) Solder and clip twelve (12).

( ) U13 0.1 uF (104)
( ) U14 0.1 uF (104)
( ) U15 0.1 uF (104)
( ) U16 0.1 uF (104)
( ) U17 0.1 uF (104)

( ) Solder and clip ten (10) leads.

( ) U18 0.1 uF (104)
( ) U19 0.1 uF (104)
( ) U20 0.1 uF (104)
( ) U21 0.1 uF (104)
( ) U22 0.1 uF (104)

( ) Solder and clip ten (10) leads.

Bit Regen Option
( ) C8 0.1 uF (104)

Bypass capacitors are installed in the capacitor outlines marked with a filled in dots. They have no "C" designator.
( ) U1 0.1 uF (104)
( ) U2 0.1 uF (104)
( ) U3 0.1 uF (104)

( ) Solder and clip eight (8) leads.

Clock Option
( ) C19 22 pF (220 or 22J)
( ) C20 22 pF (220 or 22J)

Bypass capacitors are installed in the capacitor outlines marked with a filled in dots. They have no "C" designator.
( ) U6 0.1 uF (104)

( ) Solder and clip six (6) leads.

This completes the capacitor installation. You should have no remaining capacitors.

( ) No capacitors remaining.

Diodes

NOTE: Diodes are polarity sensitive devices. Diodes are mounted flat near the surface of the board like the resistors previously installed. The cathode end of the diode is banded, and corresponds to the banded silkscreen legend and the square pad on the PCB.

Install the following diodes:

( ) D1 1N4148 (Bit Regen Option)

( ) D2 1N4148
( ) D6 1N4148

( ) Solder and clip four (4) or six (6) leads.

Light Emitting Diodes (LEDs)

LEDs are polarized components. They usually do not have their part value stamped on them. The cathode end of the LED is indicated by a flat side on the body of the part. LEDs also have their cathode lead shorter than their anode lead. The cathode lead is the one which goes into the square pad on the PCB.

NOTE: If you are installing the 9600 bps modem inside a TNC 2, you may wish to use the TNC 2 LEDs for both 1200 (normal) operation as well as 9600 bps operation. If this is the case, DO NOT install the LEDs D3, D4 and D5.

Depending on your installation, you may wish to leave enough lead length on the LEDs to bend them over the edge of the PC board. Or, you may wish to mount them flush to the top surface of the PC board. Check the mechanical clearances in your proposed location for the modem, then proceed to install the LEDs.

( ) D3 LED
( ) D4 LED
( ) D5 LED

( ) Solder and clip zero (0) or six (6) leads.

Transistor

NOTE: The transistor is a power field-effect type (FET), selected for keying a radio transmitter. The metal tab on the transistor body is connected to the drain, which is the signal for keying the radio. Mount the body of this transistor close to the PC board to ensure the tab does not come into contact with the metal cabinet of the TNC (if mounting into a TNC). If the tab were to come into contact with the case, either an intermittent or steady key of the radio will result.

( ) Q1 VN10KM

( ) Solder and clip three (3) leads.

Male Headers

The 2-, 3-, and 20-pin male headers will next be installed. The plastic body of the part should rest flush with the top surface of the PC board. The short end of the pins goes into the PC board, the long end sticks up.

WARNING: Do not hold these parts with your fingers as they quickly get very hot while soldering in place.

( ) JP2 2 pin
( ) JP3 2 pin
( ) JP4 3 pin
( ) JP5 2 pin
( ) JP6 2 pin
( ) P2 20 pin

CrystalCrystal: (Clock Option)

The crystal, which is part of the clock option, should lay flat against the surface of the PC board. Do not bend the leads sharply at the body of the crystal; instead, form a large radius curve with the leads to act as a strain relief.

( ) Y1 Crystal 4.9152 MHz

( ) Solder and clip two (2) leads.

Test Points

Test points are formed from the clipped leads of the installed resistors or capacitors. Form a lead into a loop of about 1/8" (3 mm) diameter (wrap one loop around a drill bit or similar item). The loop should stick up about 1/4" (6 mm) from the PC board so you can easily attach an alligator clip or test probe to it.

( ) TP1 EYE
( ) TP2 RXCLOCK
( ) TP3 BER
( ) GND

Installation of specific parts

The modem is nearly complete. Every part should be installed except the Integrated Circuits, connectors P1, P2 and P3, voltage regulator U23, and possibly R20, R24 and the LEDs (depending on your specific TNC installation).

Check your work for incorrect soldering and parts installation prior to completing the modem kit.

( ) Everything looks simply wonderful to me!

The next section of these instruction deals with configuring the modem to your particular installation. If you are installing the modem in a TAPR TNC 2 or clone, PK232 or PK232MBX, specific directions are given. If you are installing the modem in another TNC, you may proceed to the section headed GENERIC INSTALLATIONS. Specific directions for several other TNCs are given, however much of the required information is contained in the GENERIC INSTALLATIONS section. You should also read the sections on the TNC-2 and PK232 for ideas and hints that may apply to your TNC.

TNC 2 Internal Installation

Modem Preparation

NOTE: If you wish to use the TNC 2's existing LEDs as indicators for the 9600 modem, perform the following steps.

PTT

( ) Install a 1N4148 diode at R24 with the cathode near the notched portion of the board.

DCD

( ) Obtain and install a 1N4148 diode at D5 with the cathode to the square pad.

( ) Obtain and install a 10K resistor at R20.

( ) Cut the trace tying pads at JP1 (trace is on bottom of board).

P1

( ) Install the 5-pin right angle male header at P1. It will overhang the PC board, with the pins pointing away from the modem board.

P3

( ) Install the 20-pin female header on the bottom of the modem PC board at location P3 to occupy pins 1 through 20. (Viewing the connector socket from the bottom side of the board, pin 1 is the square pad.)

( ) Cut the provided 26-pin male header to a 20-pin length.

( ) Cut a 2-pin header from the remaining 6-pin portion of the 26-pin header.

( ) Install this 2-pin header to pins 24 and 26 on the top of the board at location P3.

U23

( ) Install the LM7805 voltage regulator at U23 on the modem board. The regulator should lay flat against the surface of the board. There is no need to fasten the regulator with screws as the modem draws very little current and the regulator will not overheat.

TNC 2 Preparation

( ) If the TNC 2 lacks a modem disconnect header at J4, cut the traces on the bottom of the TNC PC board between J4 pin pairs 1&2, 5&6, 9&10, 11&12, 13&14, 17&18, 19&20.

( ) Install the 20-pin male header on top of the TNC 2 PC board at J4.

( ) Crystal Y1 on the TNC 2 must lay down flat. You may have to unsolder and lengthen the leads to accomplish this.

( ) Jumpers or connectors at JMP6, JMP9, JMP10 and J5 may have to be clipped to ensure they do not touch the modem PC board.

( ) In general, no component on the TNC 2 PC board that will lie beneath the modem should protrude from the top of the PC board higher than a socketed IC.

NOTES:

1. In many cases, the LM324 (or LM348)op amp at U3 may not be fast enough for reliable operation at 9600 bps on the serial post to the computer. In that case, replace U3 with a TL084 or TL094 or equivalent.

2. If you desire to run the serial port to the computer at 19200bps, cut the trace that goes from pin 1 of swtich SW to pin 2 of divider U1. Connect a wire from pin 10 of U1 to pin1 of SW2. SW2 swtich 1 will now select a data rate of 19200 bps instead of 300 bps. The op amp change above will be required in addition to this change.

Power Wire

( ) Solder a wire to a push-on shunt. This will be your +12-volt DC connector to the modem.

( ) Solder the other end of the wire to the positive end of C12 on the TNC 2 PCB.

Initial Checkout

( ) Provide a heatsink for the TNC 2 voltage regulator Q3.

( ) Plug the modem into the TNC.

( ) Attach the +12-volt DC connector to the header installed at pins 24 and 26 of P3.

( ) Apply power to the TNC and verify that +5-volts appears across pins 7 and 14 of IC location U3 on the modem board.

( ) Remove power from the TNC.

( ) Remove the modem from the TNC.

Observing static handling precautions, install the following ICs on the modem:

( )	U4	LM393
( )	U5	TL082
( )	U7	74HC74
( )	U8	CD4006B
( )	U9	74HC74
( )	U10	CD4006B
( )	U11	74HC86
( )	U12	74HC4538
( )	U13	16V8 or 18CV8
( )	U14	16V8 or 18CV8
( )	U15	27C64 labelled "STATE 2.0"
( )	U16	74HC574
( )	U17	27C64 labelled "TX9600 1.0"
( )	U18	74HC574
( )	U19	74HC14
( )	U20	AD7523
( )	U21	74HCT393
( )	U22	TL084

Bit Regen Option		
( )	U1	16V8 or 18CV8 BitRegen
( )	U2	CD40105B
( )	U3	74HC14
Clock Option		
( )	U6	74HC4060

Check for proper installation of all IC chips. Be especially careful about pins folded under chip bodies, or overhanging the side of a socket.

( ) Install a shunt on JP3.

( ) Install a shunt on JP4 pins 2&3 (directly beneath the shunt on JP3).

( ) Install a shunt on JP2 only if you are using the clock option.

( ) Bend the leads of the header JP6 to form a right angle with the connector pointed towards the front panel of the TNC 2.

( ) Install a lead from the cathode end of D3 to the cathode end of CR21 on the TNC 2 PC board.

( ) Install a lead from the ungrounded pad of JP1 (the round pad, not the square one) to the cathode (banded) end of CR15 on the TNC 2 PC board (near the modem disconnect header of the TNC).

( ) Install the modem on the TNC 2 and verify that no contact is made between jumpers or other conductors on the TNC 2 PCB to the bottom of the modem PCB.

( ) Locate the front panel of the TNC 2 and note the location of the notch on the modem PCB. Drill an appropriate hole for a SPST switch to be mounted on the front panel of your TNC 2. It will be located between the TAPR logo and the LED labels.

( ) Attach a 2-pin female header to the switch, using short, flexible leads and the provided connector into JP6 on the modem board.

( ) Plug the 2-pin connector into JP6 on the modem PC board.

( ) Set the switch to the open position. This selects 9600 bps operation and will be needed for the tests that follow.

( ) If you have NOT installed the clock option on the modem, set the TNC 2 radio data rate to 9600 bps using the DIP switch on the back of your TNC and ensure that no shunt is on JP2.

NOTE: If you use a switch, and if you have the internal clock option installed and selected on the modem, the radio port data rate will automatically be selected according to the modem in use. The TNC 2 DIP switch may then be left at the 1200 (or 300) bps selection.

( ) Leave the TNC 2 out of the case.

( ) Apply power to the TNC and verify that the TNC signs on as normal.

NOTE: If the TNC seems sluggish, or takes a long time to reset, or never resets and signs on, check your power supply voltage to the TNC. The modem adds 50 mA or so of current drain, and a marginal power supply may cause the system to exhibit this symptom. The modem is not at fault; replace the power supply before proceeding!

( ) Place a jumper across pins 1 and 2 of modem connector P1.

( ) Preset R11 on the modem board to full CCW, then 1/8 turn CW.

( ) Preset R21 to mid-range.

( ) Command your TNC to ignore DCD. This is the **FULLDUP ON** command if you are using TAPR firmware.

( ) Note that the modem's DCD LED is now on. This tells you that the modem is "hearing" and decoding its transmit data via the loopback connection.

( ) Issue a connect to yourself. This will check out the receive decode portion of the modem. Note that the PTT LED will flash on the modem.

You may restore normal operation to your TNC by placing a shunt on JP6 (or closing a switch wired to JP6), and setting the radio port data rate to whatever data rate you normally use via the DIP switch on the rear of the TNC 2 (this is automatic if you are using the internal clock option). Remember to reset **FULLDUP OFF** or your transmitter will gleefully step on other stations' signals!

At this point, initial checkout is complete. You will next have to interface the unit to your radio, modify the radio as necessary, and set the R11 compensation and R21 output level for the correct transmitter deviation.

Consult the manual from Mike Curtis, WD6EHR, for general radio interfacing information.

When you have performed the interface, proceed to the section in this manual entitled **FINAL CHECKOUT.**

PK232 Internal Installation

The following directions apply to PK232s with the PakMail option installed as a daughterboard. PK232MBX units which do not have a daughterboard are covered in a later section of this manual. This section assumes you have the TAPR PK232 Modem Disconnect Header modification kit. If you do not, one may be obtained from TAPR. If you prefer to not use the modem disconnect, see below for further instructions. In addition to the TAPR Modem Disconnect kit, you may wish to use the TAPR PK232MBX Installation kit, which contains prewired plug 'n' play harness and all hardware needed for installing the 9600 bps modem inside your PK232MBX.

Modem Preparation

Perform the following steps to complete assembly of your modem prepared for internal PK232 installation.

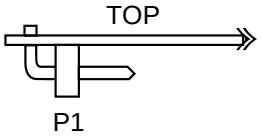
U23

( ) Install the LM7805 voltage regulator at U23 on the modem board. The regulator should lay flat against the surface of the board. There is no need to fasten the regulator with screws as the modem draws very little current and the regulator will not overheat.

P1

NOTE: The 5-pin right-angle male header will be installed on the BOTTOM side of the modem PC board.

( ) Place the 5-pin right angle connector on the bottom (solder) side of the modem PC board. It should rest on the bottom surface of the board. The pins from the connector should "point" towards the PC board, not away from it. See illustration below.



( ) Check the clipped leads from R1-R6 and C1-C9 and verify that they are flush, or nearly flush, with the PC board. Clip and reheat the connections as necessary. This will ensure proper fit of the mating connector, attached later.

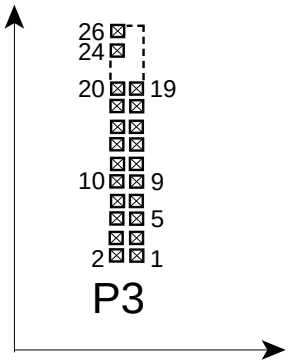
( ) Solder the 5 pins of the connector to the top of the PC board.

P3

Study the illustration below before mounting P3.

( ) Cut the supplied 26-pin male header to a 20-pin header.

( ) Solder the header to the PC board so it occupies pins 1 through 20 of P3. The short pins go into the PC board; the long pins stick up from the top of the PC board.



( ) Cut a 2-pin header from the remaining 6-pin portion of the header used for P3.

( ) Solder this connector to pins 24 and 26 of location P3.

Jumpers

( ) Be sure you have NO shunts installed at JP2, JP3, JP4, JP5 or JP6.

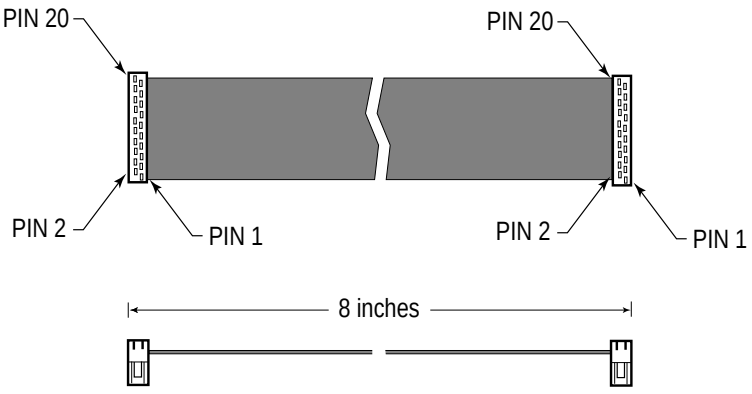
Options

( ) The CLOCK option, if installed, must be disabled by leaving JP2 open.

( ) The BIT REGENERATOR option, if installed, must be removed. This is done by simply removing ICs U1, U2 and U3 from their sockets.

Cabling

( ) Fabricate an 8" (20 cm) long cable with a 20-pin female IDC header at each end, such that pins 1 are tied together, pins 2 are tied together, etc., through pins 20.



( ) Fabricate a 6" (15 cm) long single-wire cable using a two-pin header shell at each end.

( ) Fabricate a 7" (17.5 cm) long cable with a push-on shunt at one end and the other end free.

( ) Fabricate a 5-wire cable 4" (10 cm) long using a 5-pin connector shell using ribbon cable as follows:

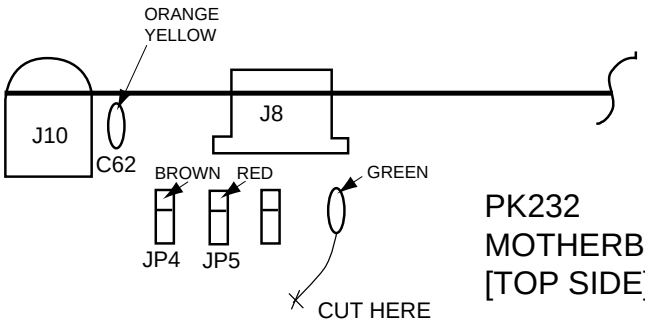
Pin 1	Brown
Pin 2	Red
Pin 3	Orange
Pin 4	Yellow
Pin 5	Green

PK232 Preparation

( ) Remove the case from the PK232 by removing the six (6) screws that fasten it together.

( ) If you have not already done so, fabricate, install and checkout the TAPR PK232 Modem Disconnect kit.

( ) Using a sharp knife, carefully cut the trace from Pin 5 of J8 (external modem connector) on the top of the PC board as shown below.



PK232 MOTHERBOARD [TOP SIDE]

( ) Ensure jumpers JP4, JP5 and JP6 on the PK232 motherboard are installed at the center and inboard pins (away from the back edge of the PK232).

( ) Solder the five (5) wires from the five-wire cable fabricated above to the PK232 motherboard as follows:

Brown	JP4 pin nearest back edge of PK232
Red	JP5 pin nearest back edge of PK232
Orange	Exposed lead of C62 bearer back edge of PK232
Yellow	Exposed lead of C62 bearer back edge of PK232
Green	Feedthrough just inboard of J8 Pin 5

( ) Solder the free end of the lead with the shunt attached to either center pin of SW1.

( ) Remove the two screws on the PK232 motherboard in the center (one at the rear edge between J7 and J8, the other near U30 and Q10 towards the front panel of the unit).

Modem Integration

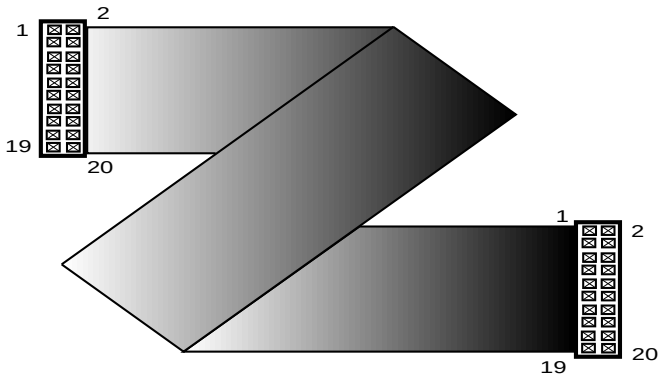
( ) Attach the 5-pin connector from the cable soldered to the PK232 motherboard near J8 to P1, on the underside of the modem.

( ) Using 3/4" #6 spacers and 7/8" 6-32 screws, install the modem on the PK232 motherboard, spacing above the motherboard and using the two screw holes just vacated.

( ) Place the free end of the wire attached to SW1 to pins 24 and 26 of P3 on the modem.

( ) Install the wire with the two-pin connectors as follows: One end at JP2 terminal 5 of the PakMail daughterboard. The other end at the JP6 pin nearer the silkscreen legend "U22" on the modem board.

( ) Form the 20-pin cable into a "Z" shape as shown below.



( ) Insert one end into the modem header P3, with pin 1 near the silkscreened dot on the board.

( ) Remove any jumpers from the Modem Disconnect header P1.

( ) Insert the other end of the 20-pin cable into the Modem Disconnect header, P1, with pin 1 near the silkscreen legend "P1".

Initial Checkout

Apply power to the modem and verify that +5 volts appears between U13 pin 20 and U13 pin 10.

Remove power from the modem and install the following ICs:

( )	U4	LM393
( )	U5	TL082
( )	U7	74HC74
( )	U8	CD4006B
( )	U9	74HC74
( )	U10	CD4006B
( )	U11	74HC86
( )	U12	74HC4538
( )	U13	16V8 or 18CV8
( )	U14	16V8 or 18CV8
( )	U15	27C64 labelled "STATE 2.00"
( )	U16	74HC574
( )	U17	27C64 labelled "TX9600 1.0"
( )	U18	74HC574
( )	U19	74HC14
( )	U20	AD7523
( )	U21	74HCT393
( )	U22	TL084

Be sure all the ICs are properly seated, and that no pins are folded under a chip or hanging over the edge of a socket.

( ) Apply power verify that the PK232 signs on normally.

NOTE: If the PK232 seems sluggish, or takes a long time to reset, or never resets and signs one, check your power supply voltage to the PK232. The modem adds 50 mA or so of current drain, and marginal power supply (one rated at 500 mA, for example) will cause the system to exhibit this symptom. The modem is not at fault; replace the power supply before proceeding!

( ) Place a jumper across pins 1 and 2 of the PK232 "EXT MODEM" connector on the rear panel of the PK232.

( ) Preset R11 on the modem board to full CCW, then 1/8 turn CW.

( ) Preset R21 to mid-range.

( ) Issue the following commands to the PK232:
HBAUD 9600
FULLDUP ON

These commands will set the HDLC data rate to 9600 bps and tell the PK232 to ignore the DCD LED.

( ) Note that the modem's DCD LED is off.

( ) Issue the command
ALTMODEM 1

and the DCD LED should illuminate on the modem board. This tells you that the modem is "hearing" and decoding its transmit data via the loopback connection.

( ) Issue a connect to yourself. This will check out the receive decode portion of the modem. Note that the PTT LED will flash on the modem along with the "SEND" LED on the PK232 front panel.

You may restore normal operation to your PK232 by issuing the **ALTMODEM 0** command to select the normal modem, and setting **HBAUD** to whatever data rate you normally use. Remember to reset **FULLDUP OFF** or your transmitter will gleefully step on other stations' signals!

At this point, initial checkout is complete. You will next have to interface the unit to your radio, modify the radio as necessary, and set the R11 compensation and R21 output level for the correct transmitter deviation.

Consult the manual from Mike Curtis, WD6EHR, for general radio interfacing information.

When you have performed the interface, proceed to the section in this manual entitled **FINAL CHECKOUT.**

PK232MBX (without daughterboard) Internal Installation

The following directions apply to PK232s above serial number 45933 with the PakMail function installed on the motherboard. If your unit has a daughterboard card plugged into sockets on the motherboard labeled U2 and U4, refer to the "PK232 Internal Insallation" directions.

This section assumes you have the TAPR PK232 Modem Disconnect Header modification kit. If you do not, one may be obtained from TAPR. If you prefer to not use the modem disconnect, refer to the "Generic Installations" section of the manual.

In addition to the TAPR Modem Disconnect kit, you may wish to use the TAPR PK232MBX Installation kit, which contains prewired plug 'n' play harness and all hardware needed for installing the 9600 bps modem inside your PK232MBX. This kit is available from TAPR.

Modem Preparation

Perform the following steps to complete assembly of your modem prepared for internal PK232 installation.

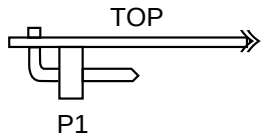
U23

( ) Install the LM7805 voltage regulator at U23 on the modem board. The regulator should lay flat against the surface of the board. There is no need to fasten the regulator with screws as the modem draws very little current and the regulator will not overheat.

P1

NOTE: The 5-pin right-angle male header will be installed on the BOTTOM side of the modem PC board.

( ) Place the 5-pin right angle connector on the bottom (solder) side of the modem PC board. It should rest on the bottom surface of the board. The pins from the connector should "point" towards the PC board, not away from it. See illustration below.

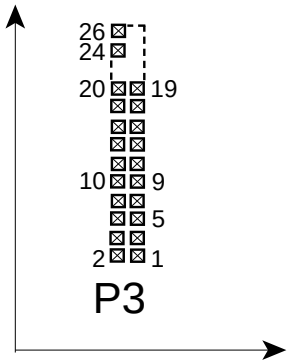


( ) Check the clipped leads from R1-R6 and C1-C9 and verify that they are flush, or nearly flush, with the PC board. Clip and reheat the connections as necessary. This will ensure proper fit of the mating connector, attached later.

( ) Solder the 5 pins of the connector to the top of the PC board.

P3

Study the illustration below before mounting P3.



( ) Cut the supplied 26-pin male header to a 20-pin header.

( ) Solder the header to the PC board so it occupies pins 1 through 20 of P3. The short pins go into the PC board; the long pins stick up from the top of the PC board.

( ) Cut a 2-pin header from the remaining 6-pin portion of the header used for P3.

( ) Solder this connector to pins 24 and 26 of location P3.

Jumpers

( ) Be sure you have NO shunts installed at JP2, JP3, JP4, or JP5.

Options

( ) The CLOCK option, if installed, must be disabled by leaving JP2 open.

( ) The BIT REGENERATOR option, if installed, must be removed. This is done by simply removing ICs U1, U2 and U3 from their sockets.

PK232 Preparation

( ) Remove the case from the PK232 by removing the six (6) screws that fasten it together.

( ) If you have not already done so, fabricate, install and checkout the TAPR PK232 Modem Disconnect kit.

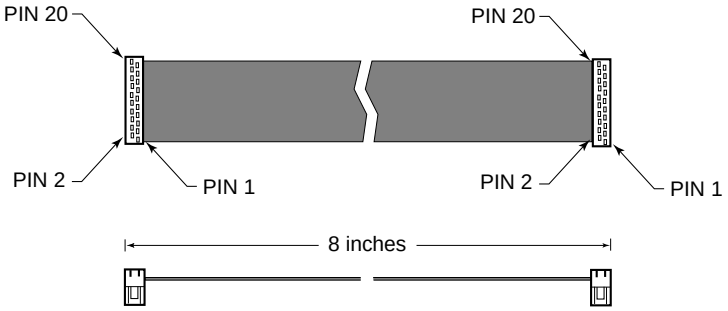
( ) Remove the two screws on the PK232 motherboard in the center (one at the rear edge between J7 and J8, the other near U38 and Q10 towards the front panel of the unit).

( ) Remove the jumper at JP-8.

NOTE: Skip to Modem Integration Using TAPR PK232MBX Installation Kit. If you are using the TAPR PK232MBX INstallation kit.

Cabling - Not using the PK232MBX Installation Kit

( ) Fabricate an 8" (20 cm) long cable with a 20-pin female IDC header at each end, such that pins 1 are tied together, pins 2 are tied together, etc., through pins 20.



( ) Fabricate a 8" (20 cm) long single-wire cable using a two-pin header shell at one end and a stripped, tinned wire at the other end.

( ) Fabricate a 3.5" (9 cm) long cable with a push-on shunt at one end and a stripped, tinned wire at the other end..

( ) Fabricate a 5-wire cable 4" (10 cm) long using a 5-pin connector shell using ribbon cable as follows:

Pin 1	Brown
Pin 2	Red
Pin 3	Orange
Pin 4	Yellow
Pin 5	Green

Modem Integration

( ) Ensure that JP4, JP5 and JP6 on the PK232MBX motherboard are installed at the "B" positions for each of these jumpers.

( ) Attach the 5-pin connector to P1, on the underside of the modem.

( ) Using 3/4" #6 spacers and 7/8" 6-32 screws, install the modem on the PK232 motherboard, spacing above the motherboard and using the two screw holes just vacated.

( ) Solder the free end of the 3.5" wire to J13 pin 5.

( ) Place the shunt on the free end of the wire soldered to J13 pin 5 to pins 24 of P3 on the modem.

( ) Solder the free end of the 8" wire with the two-pin shell shunt attached to J13 pin 2.

( ) Place two-pin shell end of the 8" wire just soldered to J13 pin 2 to JP6 on the modem. The single wire in this connector shall connects to the pin of JP6 nearer the label "U22".

( ) Solder the five (5) wires from the five-wire cable fabricated above to the PK232MBX motherboard as follows:

Brown	JP4 end "A"
Red	JP5 end "A"
Orange	J13 pin 9
Yellow	J13 pin 9
Green	JP8 center pin

Proceed to Further Steps - All PK232MBX Installations

Modem Integration Using TAPR PK232MBX Installation Kit

( ) Remove any shunts on jumpers JP4, JP5 and JP6 on the PK232mbx motherboard.

( ) Attach the 5-pin connector labelled "P1" from the wiring harness to P1, on the underside of the modem.

( ) Using the 3/4" #6 splacers and 7/8" 6-32 screws, install the modem on the PK-232 motherboard, spacing above the motherboard and using the two screw holes vacated above.

( ) Plug the shell marked "#1" from the wiring harness to J13 on the PK232MBX mother board.

( ) Plug the shell marked "#2" from the wiring harness to JP4, JP5, and JP6 on the PK232MBX motherboard.

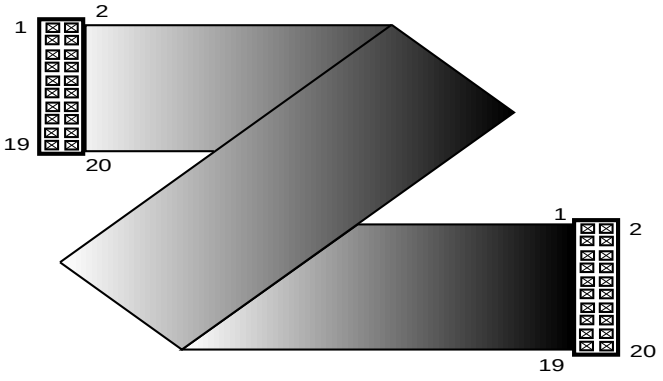
( ) Plug the shell marked "#3" from the wiring harness to JP8 on the PK232MBX motherboard.

( ) Plug the shell marked "#4" from the wiring harness to P3 pins 24 and 26 on the 9600 modem. The single wire in this connector goes to pin 26.

( ) Plug the shell marked "#5" from the wiring harness to JP6 on the 9600 modem. The single wire connects to the pin on JP6 nearer the legend "U22".

Further Steps - all PK232MBX Installations

( ) Form the 20-pin cable into a "Z" shape as shown below.



( ) Insert one end into the modem header P3, with pin 1 near the silkscreened dot on the board.

( ) Remove any jumpers from the Modem Disconnect header P1.

( ) Insert the other end of the 20-pin cable into the Modem Disconnect header, P1, with pin 1 near the silkscreen legend "P1".

Initial Checkout

Apply power to the modem and verify that +5 volts appears between U13 pin 20 and U13 pin 10.

Remove power from the modem and install the following ICs:

( )	U4	LM393
( )	U5	TL082
( )	U7	74HC74
( )	U8	CD4006B
( )	U9	74HC74
( )	U10	CD4006B
( )	U11	74HC86
( )	U12	74HC4538
( )	U13	16V8 or 18CV8
( )	U14	16V8 or 18CV8
( )	U15	27C64 labelled "STATE 2.00"
( )	U16	74HC574
( )	U17	27C64 labelled "TX9600 1.0"
( )	U18	74HC574
( )	U19	74HC14
( )	U20	AD7523
( )	U21	74HCT393
( )	U22	TL084

Be sure all the ICs are properly seated, and that no pins are folded under a chip or hanging over the edge of a socket.

( ) Apply power verify that the PK232 signs on normally.

NOTE: If the PK232 seems sluggish, or takes a long time to reset, or never resets and signs one, check your power supply voltage to the PK232. The modem adds 50 mA or so of current drain, and marginal power supply (one rated at 500 mA, for example) will cause the system to exhibit this symptom. The modem is not at fault; replace the power supply before proceeding!

( ) Place a jumper across pins 1 and 2 of the PK232Mbx "EXT MODEM" connector on the rear panel of the PK232MBX.

( ) Preset R11 on the modem board to full CCW, then 1/8 turn CW.

( ) Preset R21 to mid-range.

( ) Issue the following commands to the PK232MBX:
HBAUD 9600
FULLDUP ON

These commands will set the HDLC data rate to 9600 bps and tell the PK232 to ignore the DCD LED.

( ) Note that the modem's DCD LED is off.

( ) Issue the command
ALTMODEM 1

and the DCD LED should illuminate on the modem board. This tells you that the modem is "hearing" and decoding its transmit data via the loopback connection.

( ) Issue a connect to yourself. This will check out the receive decode portion of the modem. Note that the PTT LED will flash on the modem along with the "SEND" LED on the PK232 front panel.

You may restore normal operation to your PK232MBX by issuing the **ALTMODEM 0** command to select the normal modem, and setting **HBAUD** to whatever data rate you normally use. Remember to reset **FULLDUP OFF** or your transmitter will gleefully step on other stations' signals!

At this point, initial checkout is complete. You will next have to interface the unit to your radio, modify the radio as necessary, and set the R11 compensation and R21 output level for the correct transmitter deviation.

Consult the manual from Mike Curtis, WD6EHR, for general radio interfacing information.

When you have performed the interface, proceed to the section in this manual entitled **FINAL CHECKOUT.**

AEA PK88

Mechanical

The modem will not easily fit inside the PK88. The heatsink for the PK88 voltage regulator is in the way and has to be trimmed. Crystal XTAL1 and capacitors C19, C36 and C39 must be laid down. Jumpers JP3 and JP7 may have to be trimmed. TAPR has not performed an internal installation. The following instructions are for an external installation.

The modem should be mounted in its own shielded metal cabinet with all leads properly bypassed for the RF environment it is expected to operate in. Shielded cable should be used to connect the modem to the TNC, and this cable should be as short as practical for reasons of electrical interference.

Electrical

The PK88 brings its external modem connections to otherwise unused pins of the **RS-232C** 25-pin serial port connector. There are a number of unused pins on this connector. After you make these modifications, you will need to use a specially wired RS-232C serial port connector with your PK88. But, you will be able to easily use your PK88 with external modems such as the TAPR 9600 bps and other modems.

RS-232C connector J1 comes wired from AEA as follows:

Pin	Function
1	Frame Ground (PK88 chassis)
2	RS232 TXD (data in to PK88)
3	RS232 RXD (data out from PK88)
4	RS232 RTS (signal in to PK88)
5	RS232 CTS (signal out from PK88)
6	RS232 DSR (output, pulled to +10 inside PK88)
7	Signal Ground (PK88 signal)
8	RS232 DCD (output from PK88)
9	n/c
10	may be jumpered to pin 6 via PK88 internal jumper JP9
11	n/c
12	n/c
13	TTL CLK - output from PK88 at 32x radio channel data rate
14*	TTL DCD - input to PK88 from external modem
15*	TTL RXD - input to PK88 from external modem
16*	TTL TXD -output from PK88 to external modem
17	Ground, same as pin 7
18	n/c
19	n/c
20	n/c
21	n/c
22	n/c
23	frame ground
24	n/c
25	n/c

NOTE: The signals marked with an asterisk (*****) are only enabled when the appropriate internal jumper is placed in the PK88, which simultaneously disables the internal modem.

Connector J1 will be modified to use the following pins:

12	Ground
13	TTL 32x clk from PK88
14*	TTL DCD to PK88
15*	TTL RXD to PK88
16*	TTL TXD from PK88
18	TTL RTS from PK88
19	TTL RTS to PK88 internal modem
21	TTL RXD from internal modem
22	TTL DCD from internal modem
24	Switched +12v from PK88

After performing these modifications, the PK88 will require the following pins to be jumpered in the RS-232C serial port cable connector to enable the internal modem for normal use:

Pin 14 to pin 22 (enables radio channel DCD)
Pin 15 to pin 21 (enables radio channel RXD)
Pin 18 to pin 19 (enables radio channel PTT)

Finally, be absolutely certain that your RS-232C cable doesn't connect pins 13-16, 18, 19, 21, 22 or 25 (these are almost never used, and certainly not by PCs such as Amateurs use!).

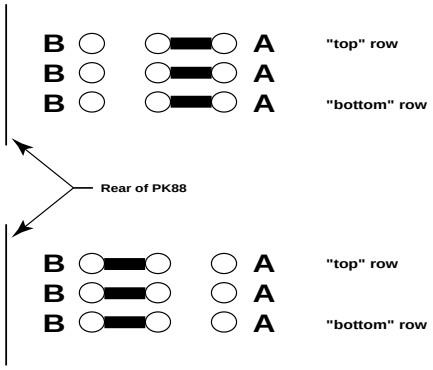
PK88 Preparation

( ) Remove power from the PK88. (This means to physically disconnect the power supply from the jack on the PK88, not merely turning it off!)

( ) Remove the PK88 from its cabinet, and remove the PC board from the cabinet base.

( ) Place all three JP4 jumpers toward rear edge of PC board and center pins.

WAS:



NOW:

( ) On the bottom of the PK88 PC board add the following wire jumpers:

JP4 center row pin "A" to J1 pin 21 (rxd from internal modem)
JP4 top row pin "A" to J1 pin 22 (dcd from internal modem)
JP4 bottom row pin "A" to pin "B"
J1 pin 7 to J1 pin 12 (gnd)
Junction of R10/R11 to J1 pin 19 (rts to internal modem)
IC12 pin 17 to J1 pin 18 (rts from PK88)
Plus side of C2 to J1 pin 24 (switched +12v from PK88)

( ) On the bottom of the PK88 PC board, cut the trace leading away from the junction of R10/R11.

( ) Reassemble the PK88.

( ) Wire an RS-232C cable to your computer and make sure the PK88 end of the cable is wired as follows:

Pins 1-8, 10, 17 and 23 as before.
Pin 18 jumpered to pin 19.
Pin 15 jumpered to pin 21.
Pin 14 jumpered to pin 22.

( ) Apply power to the PK88 and verify that it works normally before proceeding. Include an on-the-air test to verify the internal modem is functioning properly.

( ) Construct the TAPR 9600 bps Modem kit. Include the internal LEDs and the voltage regulator, but **do not install the internal clock or bit regenerator options**.

( ) Do **not** install jumpers at JP2, JP3, JP4, or JP5 of the 9600 bps modem.

( ) Wire an RS-232C cable to your computer and make sure the PK88 end of the cable is wired as follows:

PK88 RS-232C — 9600 bps Modem 26-pin header

pins 1-8, pin 10, pin 17, and pin 23 as before.

12	Ground	15
13	32x Clk —>	11
14	DCD <—	1
15	RXD <—	17
16	TXD —>	19
18	RTS —>	5
19	RTS <—	6
21	RXD —>	18
22	DCD —>	2
24	+12v	26

( ) Set the PK88 to **FULLDUP ON** and **HBAUD 9600**.

( ) Place a jumper at modem P1 pins 1 and 2.

( ) The **DCD** LED should illuminate. If it does not, troubleshoot the modem and cabling.

( ) Connect to yourself.

( ) Note that the **PTT** LED on the modem flashes when you connect.

( ) Disconnect.

( ) Set **FULLDUP OFF**.

Remember to short JP4 on the modem to enable the PK88 internal modem. You must also reset **HBAUD 1200** (or 300) to use the internal modem.

At this point, initial checkout is complete. You will next have to interface the unit to your radio, modify the radio as necessary, and set the R11 compensation and R21 output level for the correct transmitter deviation.

Consult the manual from Mike Curtis, WD6EHR, for general radio interfacing information.

When you have performed the interface, proceed to the section in this manual entitled **FINAL CHECKOUT.**

AEA PCB-88

KA1BOY lent TAPR his PCB-88 TNC to interface the TAPR 9600bps modem. The interface is very straightforward. The PCB88 includes a 26-pin modem disconnect header that is very similar to the one in a TNC-2

PCB88 Mods

Please refer to the PCB88 component layout diagram located on page C-1 of the PCB-88 Operations Manual.

The PCB88 must be slighly modified to connect to the 9600 bps modem:

( ) Locate modem disconnect header J1 on the PCB88 PC board. This is the 26-pin male header near the rear of the PC board.

( ) On the solder (bottom) side of the board, carefully cut the following traces:
Jumper from J1 pin 1 to J1 pin 2
Jumper from J1 pin 5 to J1 pin 6
Jumper from J1 pin 17 to J1 pin 18

( ) On the component side of the board, temporarily place push-on shunts across J1 pin 1 to 2, 5 to 6, and 17 to 18.

( ) Verify the PCB-88 works as it did before the modifications in this section.

9600bps Modem Rev 1

( ) DO NOT INSTALL the 5-volt regulator IC U23.

( ) DO NOT INSTALL the internal clock option

( ) DO NOT INSTALL the bit regenerator option.

( ) Place a push-on shunt at JP3 (TNC 2).

( ) Be sure no jumper is installed at JP2 (INT CLK), JP4 or JP5.

( ) On the circuit side of the PC board, carefully cut the trace between P2 pin 11 and P2 pin 12.

( ) Install a 26-pin male header at P3.

Modem Checkout

( ) Fabricate a 26-pin cable to tie between the PCB-88 modem disconnect and the 26-pin male header on the 9600 bps modem.

( ) Install the 26-pin cable, so that pin 1 of the modem goes to pin 1 of the PCB-88 disconnect, pin 2 to pin2 2, etc.

( ) Install a jumper on the 9600 modem at JP6 labelled TNC MODEM. This will enable the internal modem in the PCB-88.

( ) Verify the PCB-88 works as before.

( ) Installa loop-back jumper at 9600 modem P1 pins 1 and 2

( ) Remove the TNC MODEM jumper from the 9600 modem (JP6). This enables the 9600 modem.

( ) Set PCB-88 HBAUD to 9600 and FULLDUP to ON

( ) Connect to yourself and verify that the PTT and DCD LEDs of the 9600 modem glow.

( ) Disconnect from yourself.

Final Steps

The 9600 modem and PCB-88 are now checked and verified. You must now locate a suitable mechanical location for the 9600 modem and install it. If this is inside your PC, beware of electrical noise that may be induced by board location and cable routing. If external, be sure to use a suitable shielded enclosure and cabling between the PCB-88 and the 9600 modem.

You will next have to interface the unit to your radio, modify the radio as necessary, and set the R11 compensation and R21 output level for the correct transmitter deviation.

Consult the manual from Mike Curtis, WD6EHR, for general radio interfacing information.

When you have performed the interface, proceed to the section in this manual entitled **FINAL CHECKOUT.**

Enjoy 9600 baud operation with your PCB-88.

DRSI PC*PA

PC*PA Interface

The information presented is specific to the Type 1 PC*PA (port 0 fixed at 1200 bps with internal modem, port 1 set up for external modem). Other styles of the PC*PA may vary, so double check your unit before proceeding!

PC*PA Preparation

The external modem port must be set up for TTL interface levels. Information to do this is included in the Hardware Reference Manual provided with the PC*PA. Please read that section of your manual before proceeding with the following steps.

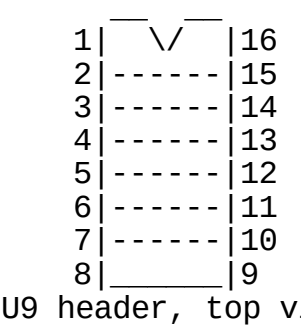
1) If you have a very early PC*PA, you will find the RS232 level translator chip is U9 (MC145406). If you don't have this configuration, skip to step 2.

NOTE! This information for the earlier units is based on schematic diagram analysis only!

( ) Remove your PC*PA from your computer.

( ) Locate U9 (MC145406) and remove it.

( ) Prepare a 16-pin header, jumpering pins 2-15, 3-14, 4-13, 5-12, 6-11, 7-10. Leave pins 1, 8, 9 and 16 unconnected.



U9 header, top view

( ) On the circuit side of the PC*PA PC board, cut the trace going from U9 pin 7 to U7 pin 28 (the 8530 SCC chip).

( ) On the circuit side of the PC*PA PC board, solder an insulated jumper wire from U9 pin 7 to U7 pin 26.

( ) Place a jumper at JP2 on the PC*PA to power the TAPR modem.

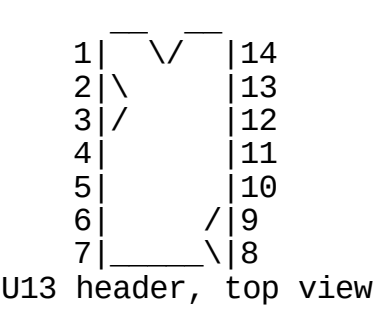
( ) Proceed to Modem Preparation below.

2) If you have a later PC*PA, you will find TTL <--> RS232 level conversion is handled by U13 (MC1488) and U14 (MC1489). If this is the case:

( ) Remove the PC*PA from your computer.

( ) Locate U13 (MC1488) and remove it.

( ) Prepare a 14-pin header, jumpering pins 2-3 and 8-9. Pins 1, 4-7 and 10-14 should remain unconnected.

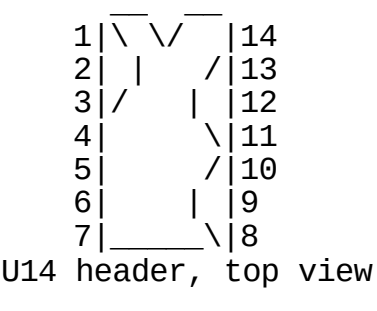


U13 header, top view

( ) Install the 14-pin header at U13.

( ) Locate U14 (MC1489) and remove it.

( ) Prepare a 14-pin header, jumpering pins 1-3, 8-10 and 11-13. Pins 2,4-7, 9, 12 and 14 should remain unconnected.



U14 header, top view

( ) Install the 14-pin header at U14.

( ) Place a jumper at JP3 on the PC*PA to power the TAPR modem.

Modem Preparation

Do **NOT** use the internal clock option or BitRegen option on the 9600 modem.

( ) Install R20 and R24.

( ) Install the LEDs (D3, D4 and D5).

( ) P1 should be installed on the top of the PC board.

( ) P3 should be installed as a 26-pin male header on the top of the PC board.

( ) Install U5.

( ) You must prepare a cable to connect between the 25-pin D connector on the PC*PA and P2 on the modem. Use 8-conductor shielded cable and wire it as follows:

Function	DB-25P	26-pin Header
Shield	1 and shell	
Ground	1	15, 25
TXDB	2	19
RXDB	3	17
/RTSB	4	5
/CTSB	5	5
Ground	7	15, 25
/DCDB	8	1
+12VDC	11	26
32XCLK	15	11

( ) Install the PC*PA in your computer and connect the modem to it via the cable just prepared.

( ) Apply power to the computer and verify that +5 volts appears between modem IC socket U13 pin 20 and U13 pin 10.

( ) Remove power from the computer and install the ICs indicated beginning on the bottom of page 29 of the TAPR manual.

( ) **Ensure there is NOT a jumper placed at JP2, JP3, JP4, JP5 or JP6 on the modem.**

( ) Power up your computer and use the CONFIG22 utility supplied by DRSI to set Port 1 HBAUD to 9600 bps (**HBAUD 5**) and set DUPLEX ON (**DUPLEX 1**). Refer to the DRSI documentation for details on this.

( ) Place a jumper across pins 1 and 2 of modem connector P1.

( ) Preset R11 on the modem board to full CCW, then 1/8 turn CW.

( ) Preset R21 to mid-range.

( ) The modem's **DCD** LED should illuminate. If it does not, troubleshoot the modem and cabling.

( ) Connect to yourself on Port 1. Note that the PTT LED flashes on the modem.

( ) Disconnect.

Preliminary checkout is done. The 9600 bps modem should be installed in a well-shielded cabinet and use a minimum length shielded cable between the PC*PA and modem.

At this point, initial checkout is complete. You will next have to interface the unit to your radio, modify the radio as necessary, and set the R11 compensation and R21 output level for the correct transmitter deviation.

Consult the manual from Mike Curtis, WD6EHR, for general radio interfacing information. When you have performed the interface, proceed to the section in this manual entitled **FINAL CHECKOUT.**

TNC 1 Internal Installation

TNC 1 Preparation

Perform the following modifications to your TNC 1:

( ) Solder a jumper wire across R79 (680 ohm) located near modem disconnect J5.

If your TNC 1 already has a modem disconnect header installed at J5:

( ) Remove any jumpers placed at modem disconnect header J5.

( ) Remove extractor "ears" from J5 if present.

If your TNC 1 has no modem disconnect header installed at J5:

( ) Install the 20-pin male header provided with the modem kit at J5.

( ) Cut any default traces tying modem disconnect header pins together. These will usually be 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, and 19-20.

If you intend to mount the modem inside the TNC 1 case and plug it directly into J5:

( ) C3 and C5 are too tall and must be laid down. You may have to replace them or extend their leads to accomplish this. Lay them towards power supply diodes D9-D12.

NOTE: The following step is only necessary if you intend to use the TNC 1 internal clock and not the clock option on the 9600 bps modem.

( ) Place jumper JP7 on the TNC 1 PC board across the pin pair nearer C12 - the default is the pair farther from C12. This will run the 6809 CPU at twice normal speed (1.84 MHz). The 6809 CPU, 6522 VIA and the 6551 ACIA chips may need to be replaced with higher speed parts ("B" or -2 parts) for reliable operation at the higher speed.

Modem Preparation

( ) Install R20 and R24.

( ) Install the LEDs (D3, D4, and D5).

( ) P1 should be installed on the top of the PC board.

( ) If you are going to directly plug the modem into J5 on the TNC 1, use a 20-pin female connector installed on the bottom of the modem PC board at P3.

( ) If you are going to use a 20-pin ribbon cable to connect your modem to ease access to the LEDs and P1 radio connector, use a 20-pin male connector installed on the top of the modem PC board at P3.

( ) Install U5.

( ) Attach a wire from modem P3 pin 26 to +12 volts available at the TNC 1 wire wrap area.

Proceed with the "Generic Installation" checkout and IC installation procedures.

( ) Place a jumper at JP4 pins 1 and 2

( ) Place a jumper at JP5.

Checkout Information

The following assumes you are using TAPR/ HEATH/AEA firmware. (WA8DED firmware commands are in parentheses like this.)

( ) If you are using the TNC 1 HBAUD generator with a double-speed CPU clock, select **HBAUD 4800** (<ESC>H9600) for 9600 bps operation and **HBAUD 600** (<ESC>H1200)for 1200 bps operation. (<ESC>@C1 to enable double speed clock for WA8DED firmware.)

( ) If you are using the modem internal clock option, place a jumper on the modem at JP3. **HBAUD** (<ESC>H) will have no effect on the modem operation if this is done.

( ) Place a jumper at modem P1 pins 1 and 2.

( ) The **DCD** LED should illuminate. If it does not, troubleshoot the modem and cabling.

( ) Set **FULLDUP ON** (<ESC>@D1).

( ) Connect to yourself.

( ) Note that the **PTT** LED on the modem flashes when you connect.

( ) Disconnect.

( ) Set **FULLDUP OFF** (<ESC>@D0).

Remember to short JP6 on the modem to enable the TNC 1 internal modem. This will also restore HBAUD (<ESC>H) operation for the internal modem if you are using the modem clock option.

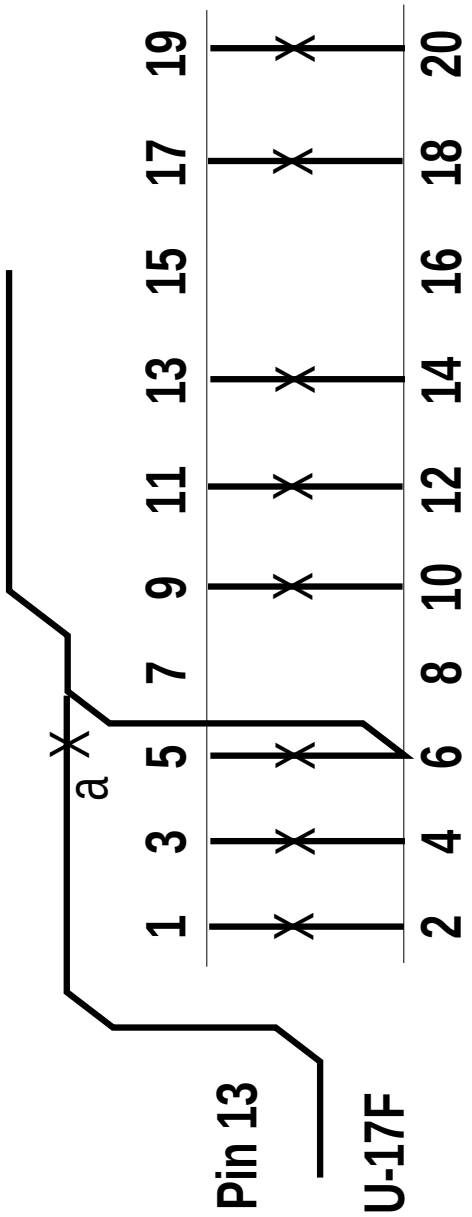
At this point, initial checkout is complete. You will next have to interface the unit to your radio, modify the radio as necessary, and set the R11 compensation and R21 output level for the correct transmitter deviation.

Consult the manual from Mike Curtis, WD6EHR, for general radio interfacing information. When you have performed the interface, proceed to the section in this manual entitled **FINAL CHECKOUT.**

PacComm Tiny-2

Thanks to Frank Anderson, W7ZTA, and Jeff Angus, WA6FWI, for the following:

Referring to the figure below, make the following modifications to the Tiny-2:



This is the solder side of the PacComm Tiny-2 Tnc disconnect header

Step:

1. cut the traces as indictaed by the 'x' marks. (9 places)
2. add jumper at 'a' between header pin 5 and line to U17.
3. Follow the instructions above for installation in a TNC 2.

Generic Installations

For installations other than the specific ones detailed above, refer to the following steps. You may wish to review the detailed information on other TNCs anyway, since much of what is outlined in those sections may apply to your particular system. Please let us know how you instal the modem in other units so we may expand the manual and share this information with others.

!!!!! IMPORTANT NOTE !!!!!

The programmable logic devices U13 and U14 are specifically programmed to support the switching requirements of the PK232, TNC 1, TNC 2 and clones thereof. If you are installing the modem in another TNC, contact the TAPR office . These chips may need to be reprogrammed to properly operate in other units. We will work with you to get the programmable logic worked out and then add the logic patterns.

TNCs that probably won't work with the 9600 bps modem are those that use "software" HDLC. This includes Kantronics units in the KPC and KAM series, the GLB PK-1, and the PMP/Baycom and C-64 software packages.

Install the following parts

P1

NOTE: P1 is usually installed on the top of the PC board with the pins facing away from the PC board. However, your specific installation's mechanical requirements may dictate another orientation. Determine the orientation required, then proceed.

( ) P1 5-pin

P3

P3 may be installed as a 20 or 26 pin male header (usually on the top of the PC board), or as a 20 pin female header (usually on the bottom of the PC board).

You should determine the requirements of your installation, then proceed. You may wish to review the specific unit installation directions, above, to help you decide option which is best for your modem.

( ) Install a 20- or 26-pin male or female header at P3.

U23

If you will be obtaining +5 volts from your installation, you will not require U23. +5 volts will then need to be applied to P3 pin 23.

The modem will draw approximately 50 mA from the 5-volt source.
If you will be providing +7 to +20 volts to the modem, then proceed with the installation of U23.

( ) Install the LM7805 voltage regulator at U23 on the modem board. The regulator should lay flat against the surface of the board. There is no need to fasten the regulator with screws as the modem draws very little current and the regulator will not overheat.

Initial Checkout

Apply power to the modem and verify that +5 volts appears between U13 pin 20 and U13 pin 10.

Remove power from the modem and install the following ICs:

( )	U4	LM393
( )	U5	TL082
( )	U7	74HC74
( )	U8	CD4006B
( )	U9	74HC74
( )	U10	CD4006B
( )	U11	74HC86
( )	U12	74HC4538
( )	U13	16V8 or 18CV8
( )	U14	16V8 or 18CV8
( )	U15	27C64 labelled "STATE 2.00"
( )	U16	74HC574
( )	U17	27C64 labelled "TX9600 1.0"
( )	U18	74HC574
( )	U19	74HC14
( )	U20	AD7523
( )	U21	74HC393
( )	U22	TL084

Clock Option

( )	U6	74HC4060

BitRegen Option

( )	U1	16V8 or 18CV8
( )	U2	CD40105B
( )	U3	74HC14

Be sure all the ICs are properly seated, and that no pins are folded under a chip or hanging over the edge of a socket.

( ) Place a jumper at JP2 (INT CLK) only if you installed the clock option and you are not going to use the TNC's clock for the 9600 bps modem.

( ) Place a jumper at JP3 (TNC 2) if required by your TNC. This will usually be needed if your TNC supplies a 16x clock (153.6 kHz for 9600 bps). If your TNC supplies a 32x clock (307.2 kHz for 9600 bps) then no jumper should be placed at JP3.

( ) Place a jumper at JP4 pins 1 and 2 (TNC 1) or pins 2 and 3 (TNC 2) if required by your TNC. This jumper is used to configure the request to send (RTS) line between your TNC's HDLC controller and the TNC's internal modem. This jumper is not used at all by the 9600 bps modem.

( ) Place a jumper at JP5 (TNC 1) if required by your TNC. This jumper provides a physical short between P3 pins 7 and 8. It is required for a TNC 1. It will cause improper operation of a TNC 2 (it will short the CON and STA LEDs)! If in doubt, leave this jumper off! It has no effect on the operation of the 9600 bps modem.

( ) Ensure no jumper is placed at JP6 (TNC MODEM), or that any switch wired to JP6 is in the open position.

( ) Apply power and verify that the TNC signs on normally.

NOTE: If the TNC seems sluggish, or takes a long time to reset, or never resets and signs one, check your power supply voltage to the TNC. The modem adds 50 mA or so of current drain, and marginal power supply may cause the system to exhibit this symptom. The modem is not at fault; replace the power supply before proceeding!

( ) Place a jumper across pins 1 and 2 of modem connector P1.

( ) Preset R11 on the modem board to full CCW, then 1/8 turn CW.

( ) Preset R21 to mid-range.

( ) Command your TNC to operate at 9600 bps (may be a software command, or may be a switch on the TNC, or may be just placing a shunt at JP6 on the modem).

( ) Command your TNC to ignore DCD. This is the FULLDUP ON command on TAPR units.

( ) Note that the modem's DCD LED is now on. This tells you that the modem is "hearing" and decoding its transmit data via the loopback connection.

NOTE: Some TNCs will not issue any transmit data until they are commanded to attempt a connection, or to enter a "calibrate" mode. If the DCD LED does not glow, try the next step. If it still does not glow, you may need to troubleshoot the modem.

( ) Issue a connect to yourself. This will check out the receive decode portion of the modem. Note that the PTT LED will flash on the modem.

You may restore normal operation to your TNC by issuing the command to select the normal modem (or placing a shunt at JP6 on the modem, or closing a switch wired to JP6), and setting the radio port data rate to whatever data rate you normally use (might be a software command, such as **HBAUD**, or a hardware switch, or automatic if you are using the internal clock option). Remember to reset **FULLDUP OFF** or your transmitter will gleefully step on other stations' signals!

At this point, initial checkout is complete. You will next have to interface the unit to your radio, modify the radio as necessary, and set the R11 compensation and R21 output level for the correct transmitter deviation.

Consult the manual from Mike Curtis, WD6EHR, for general radio interfacing information.

When you have performed the interface, proceed to the section in this manual entitled **FINAL CHECKOUT.**

FINAL CHECKOUT

( ) Remove the loopback jumper from the modem and connect the modem to a radio.

( ) Set R21 for 3 kHz deviation of your transmitter (you need a deviation meter for this!) If you lack a deviation meter, but have access to an oscilloscope (an AC voltmeter probably isn't good enough) you may adjust the deviation using the approximate technique in Alternate Deviation Setting Method, below.

( ) Get another station to send to you with his TNC in CAL mode sending a "fixed tone." Have the remote station place his TNC in CAL mode, press <K> key to activate transmitter, press space bar to send a mark or space "tone". (TAPR and PK232 TNCs do this. Kantronics TNCs don't, so another method must be used if the remote station uses a Kantronics unit).

( ) Connect on oscilloscope or a speaker/amplifier to the BER test point.

( ) With the other station sending, slowly rotate R11 for minimum popping sound. Decrease the applied signal (add attenuation in your receiver antenna line, reduce the remote station's transmit power, etc.) and adjust R11 until no further improvement is noted.

( ) If you can't get another station to send, preset R11 to 1/8 turn from full CCW and hope for the best :-) This setting is usually close to optimum for radios with 10.7 MHz/455 kHz IF lineups using a ceramic filter at the 455 kHz IF for most of the selectivity. This lineup includes most radios of the last 10 years or so.

Alternate Deviation Setting Method

( ) Connect the oscilloscope to the detector output (not amplified audio) of a narrow-band FM receiver tuned to your transmitter's frequency.

( ) Using a voice transmitter, send a full-deviation signal (shout into the microphone, for example). Most radios have a deviation limiter set to about 5 kHz peak deviation.

( ) Note the peak-to-peak voltage on the oscilloscope while receiving the signal from the preceding step.

( ) Unkey the voice transmitter and key the 9600 bps transmitter.

( ) Adjust R21 for 60% of the peak-to-peak voltage noted above.

NOTE: Unlike 1200 bps AFSK/FM packet, it is better to err slightly on the high side of transmitter deviation on a 9600 bps FSK link than to err on the low side! Too much isn't good, either, but a value up to about 4 kHz will work quite well unless the distant receiver has a very narrow passband or the transmitting and receiving ends of the link are poorly netted.

HARDWARE

This section includes a detailed circuit theory explanation and details on the functions of all connector and jumper pinouts.

Detailed Circuit Description

The TAPR 9600 bps modem is a baseband modem (meaning it works at audio and not at RF) for use with standard FM radios to produce a direct RF FSK data link.

Receiver Signal Processing

Analog Processing Section

Incoming audio from the radio FM detector (usually a quadrature detector within an IC such as a Motorola MC3357, 3359 or 3362) is applied to buffer U5A via C7/R13. C7 is a 0.1 uF capacitor selected to allow low frequency components of the incoming signal to pass, while R13 presents a high input impedance and sets the DC bias for the rest of the analog portion of the receive system.

U5A is configured as a simple voltage follower with a very high input impedance and a low output impedance. This prevents loading of the radio receiver while providing a correct termination for the input of the following filter.

U5B, along with its associated resistors and capacitors, forms a three-stage butterworth filter with a cutoff frequency of about 6 kHz. R11 provides compensation for the higher frequency end of this range, allowing a "boost" for radios whose high audio frequency response is insufficient. The available boost is only a few dB, so it can't compensate for a truly dismal radio.

The output of U5B is passed to comparator U4A, which acts as a slicer and determines when a signal is above or below the center of the incoming signal amplitude range.

Tracking of drift of the incoming signal is accomplished by virtue of the incoming signal coupling capacitor, C7.

The output from U4A will swing from near ground to the +5 VDC bus voltage via pull-up resistor R5.

Digital Processing Section

The incoming transitions from U4A are coupled to a two-stage synchronizer circuit located in programmable logic device U13. The synchronized data is then fed to flip-flop U7B as well as to State Machine U15 and U16.

U15 and U16, along with a 16x clock signal (153.6 kHz in the case of 9600 bps operation), synchronize the incoming data edges. The state machine has two outputs:

1) a recovered clock at the data rate, used to de-scramble the incoming data and optionally clock the data into an attached TNC or bit regenerator, and
2) a signal quality indicator which pulses low whenever an incoming data transition is out of limits compared to the received clock being generated by the state machine.

Descrambler

The clock signal latches incoming data from U13 to flip-flop U7B whose output level is now synchronized by the clock. Data is simultaneously clocked into shift register U9. This shift register, along with signal delay flip-flop U7A and exclusive-or gates U11C and U11D, provides a 17-stage polynomial divider to extract the NRZI bit stream from the incoming data.

The output of the descrambler, de-glitched by R26/C23, is fed to inverters U19F and U19E. U19F provides TTL level data to the attached TNC and/or bit regenerator. U19E is AC-coupled to BER test point TP2, where it may be used to drive an oscilloscope or speaker for setting a link up for best bit error rate performance.

DCD

The signal quality pulses from the state machine are buffered by U19C, then coupled via diode D6 to U19D, a schmitt trigger which, along with C24 and R25, implements a pulse stretcher. Any pulse from the state machine is remembered for several milliseconds. The time constant of this circuit, determined by R25/C24, has been chosen to provide a minimum delay when data is valid, but more importantly to minimize falsing when noise is being received.

The output from U19D is passed to U12B, a retriggerable one-shot. U12B will trigger on data edges from U7B only when U19D is in the correct state. In this manner, U19D gates U12B, while U12B ensures that the correct state of U19D is not caused by a lack of input signal. This is because the state machine's DCD function operates by looking for edges that are out of sync; it does not operate by looking for edges that are in sync. U12B therefore prevents false DCD indications that may be caused by a period of NO SIGNAL activity which might be caused by using either (a) a squelched radio (ugh!) or (b) a full-duplex repeater's not-yet-timed-out carrier.

Transmitter Signal Processing

Scrambler

Incoming TTL data is applied to flip-flop U9B, and clocked by the applied transmit clock. This latched incoming data is applied to shift register U10. This shift register, along with signal delay flip-flop U9A and exclusive-or gates U11A and U11B, provides a 17-stage polynomial multiplier to convert the incoming NRZI into a data format with higher low-frequency components.

The data stream is taken from gate U11A.

Transmit Raised-Cosine Generator

The data from the scrambler is applied to state machine U17, U18 and clocked by U21A. For every bit that is clocked into the state machine, counter U21A provides sixteen (16) states. These states are used to provide an output from U18 that does one of four things:

1) If the last bit was a one, and the current bit is a one, the output from U18 is held at its maximum value.
2) If the last bit was a zero, and the current bit is a zero, the output from U18 is held at is minimum value.
3) If the last bit was a one, and the current bit is a zero, the output from, U18 is stepped down (in 16 steps) in a pattern corresponding to the descending edge of a raised-cosine.
4) If the last bit was a zero and the current bit is a one, the output from U18 is stepped up (in 16 steps) in a pattern corresponding to the ascending edge of a raised-cosine.

The encoded values from U18 are fed to a digital-to-analog converter (D/A), U20.

Transmit Analog Signal Processing

The "stairstep" output from U20 is level-shifted by U22C and filtered by U22D. The now continuous waveform from U22D is set to the desired level for correct modulation of the attached transmitter by U22B, whose gain is controlled by trimpot R21.

The output from U22B is AC-coupled by C30, a 10 uF capacitor to allow for relatively low transmitter input impedances.

Transmit Watchdog Timer

To prevent a runaway TNC from clogging a radio channel, the PTT information is passed through a one-shot, U12A. This device is set for a few tens of seconds, to allow maximum length packets to be transmitted while preventing a stuck PTT command from jamming the radio channel. Transmitter keying is provided by power FET Q1, the familiar VN10KM.

LED Indicators

LEDs are provided to monitor +5V power (D4), PTT activation (D3) and DCD (D5).

TNC Interface Logic

The TNC interface is via a standard modem disconnect header P3. P3 uses the PacComm extensions to the TAPR disconnect in order to provide a convenient means to apply power to the modem.

Programmable logic devices (PLDs) U13 and U14 handle all configuration requirements for TAPR TNC 1 and TNC 2 or clones, AEA PK88 and PK232, and DRSI PC*PA. Special variations of these chips may be necessary for other TNCs. Contact TAPR for availability for your particular TNC.

P2 is provided to allow chaining another external modem to your TNC. This may be useful for adding a 1200 bps PSK modem as well as the 9600 bps modem for your Amateur satellite station, for example. Configuration is handled by jumpers JP2-JP6 described later in this section.

Radio Interface

The signals to and from the radio are bypassed for RF by R1-R3, R14 and C1-C6. The signals are available at 5-pin connector P1.

Optional Clock Oscillator

A 74HC4060 oscillator / divider IC with a 4.9152 MHz crystal provides normal clocking signals or 32x (307.2 kHz) or 16x (153.6 kHz) for the modem. U6 is the IC, and Y1, along with the associated resistors and capacitors, provides the feedback to ensure oscillation at the desired frequency.

Optional Bit Regenerator

DCD from an incoming signal is passed to programmable logic device (PLD) U1. U1 then applies a PTT command to the PTT watchdog via U13 and clocks in received data from the descrambler. The data is stored in first-in first-out (FIFO) buffer U2, a CD40105B. After eight (8) received clocks have accumulated, U1 begins clocking data out from U2 via a stable transmit clock (rather than the possibly-jittery receive clock from the state machine).

This process continues until DCD goes false. At this point, U1 continues to clock out the remaining data bits from U2 (this may be from 0 to 16, depending on the clock accuracy of the sending station and the bit regenerators modem).

The FIFO signals to U1 when it is empty, at which point U1 releases its PTT command. The release of PTT is delayed about 10 mSec by U3 and associated components to allow the distant TNC to finish fetching the incoming data before the bit regenerator releases local PTT. This prevents noise bursts from possibly confusing the distant TNC and causing it to lose the data just received.

At this point, the local PTT is released and the modem goes quiescent.

If, however, the modem is attached to a TNC and that TNC wishes to access the modem and its radio, the control logic in U13 will pass control to the TNC in preference to the regenerator.

This allows a network node, for example, to seize control of the channel. On the other hand, when the bit regenerator is active, the same DCD signal that enables the regenerator is also passed to the TNC, so it will normally defer its transmission.

The override function has been included for specific applications.

Jumper Functions

The following table lists the function of each jumper on the 9600 bps modem PC board. Pay careful attention when reading this section to determine interface requirements to various TNCs. Several of the jumpers have no effect at all on the operation of the 9600 bps modem but may have a significant effect on the operation of the attached TNC!

Jumper	Position	Function
JP1	OPEN	Disables DCD LED.
	CLOSED	Enables DCD LED.
JP2	OPEN	Selects clock signals from the TNC for clocking the 9600 bps modem.
	CLOSED	The internal clock option is the modem clocking source.
JP3	OPEN	Assumes the attached TNC uses a 32x clock.
	CLOSED	Assumes the attached TNC uses a 16x clock.
JP4		Selects RTS options on the attached TNC.
	1&2	P3 pins 9 and 10 are shorted together (needed by TNC 1 and clones).
	2&3	P3 pins 5 and 9 are connected together (needed by TNC 2s and clones).
JP5	OPEN	Does nothing.
	CLOSED	Shorts P3 pins 7 and 8. This is necessary for the proper operation of a TNC 1 (or clone) internal modem when the 9600 bps modem is bypassed. This position may damage a TNC 2!
JP6	OPEN	Selects the 9600 bps modem.
	CLOSED	The 9600 bps modem is bypassed and the TNC's internal modem, if any, is selected.

Radio Connector - P1

This 5-pin connector interfaces the 9600 bps modem to a radio. Note that this must be "flat response audio" and not pre-emphasized, de-emphasized or otherwise shaped. Transmitter audio injection to the radio is usually directly to the FM modulator. Receive audio from the radio is usually taken directly from the detector circuit. See the 9600 bps Radio Handbook by Mike Curtis, included with your 9600 bps modem kit, for further information on radio interfacing.

Pin	Name	Function
1	RXA	Receive Audio input. The bandpass should extend from about 100 Hz to a minimum of about 7200 Hz. Signal levels from about 100 millivolts to about two volts are acceptable. The actual range depends on the setting of R11. The input impedance is high, on the order of 100K ohms, AC-coupled.
2	TXA	Transmit Audio output. The signal level here is adjustable by R21 from a few 10s of millivolts to a couple of volts depending on the transmitter input impedance. The output impedance is on the order of 1K ohm, AC-coupled.
3	COMMON	This is power and audio ground.
4	COMMON	This is power and audio ground.
5	PTT	Transmit Push to talk output. This line goes to ground via about 100 ohms when transmitting. It can withstand about 25 volts open circuit and can sink several tens of milliamperes. It is not protected from inductive loads, such as relay coils.

Modem Disconnect - P3

The modem disconnect is used to connect the 9600 bps modem to the attached TNC. It may be wired as a 20- or 26-pin connector. If wired as a 20-pin connector, pins 21-26 are not used. Note that many signals available at the header are not used by the modem but are provided for use by the TNC. Signals that are absolutely necessary for modem operation are marked with an asterisk (like this*).

Pin	Name	Function
1*	DCD Out	Data Carrier Detect output from modem to TNC. A logic low indicates DCD.
2	DCD In	Data Carrier Detect input from TNC's modem. This signal is passed to pin 1 when the 9600 bps modem is not selected.
3	N/C	Not connected.
4	N/C	Not connected.
5*	RTS In	Request to Send input from TNC. A logic low tells the modem to transmit.

6	RTS Out	Request to Send output to TNC's modem. When the 9600 bps modem is not selected, pin 5's level is passed to this pin.
7	N/C	Not used. Routed to JP5.
8	N/C	Not used. Routed to JP5.
9	N/C	Not used. Routed to JP4.
10	N/C	Not used. Routed to JP4.
11	TXC Out	Transmit Clock output to TNC. This square wave is at 32x or 16x the data rate depending on the status of JP3.
12*	TXC In	Transmit Clock input from TNC. This signal is expected at 16x or 32x the data rate depending on the status of JP3. If the TNC does not provide this clock, it may be provided locally by the Clock Option.
13	RXC Out	Receive Clock output to TNC. This is not used by the modem and is a 32x or 1x clock depending on the state of JP3.
14	RXC In	Receive Clock input from TNC.
15*	GND	Power and signal common.
16	N/C	Not used.
17*	RXD Out	Receive Data from the 9600 bps modem.
18	RXD In	Receive Data from the TNC's modem. This signal is routed to pin 17 when the 9600 bps modem is not selected.
19*	TXD In	Transmit Data from the TNC.
20	TXD Out	Transmit Data to the TNC's modem. This pin is always shorted to pin 19.
21	N/C	Not used.
22	N/C	Not used.
23	+5V	+5V power. This is an input and should only be used if modem regulator U23 is not installed. Current drain is about 50 mA.
24	N/C	Not used.
25	GND	Power and signal common.
26*	+12V	+12V unregulated power in. This voltage should be in the range of +8 to +20 VDC and capable of supplying at least 50 mA. This signal is not needed if regulated +5 VDC is instead supplied to pin 23.

Secondary Modem Disconnect - P2

This header is provided to enable chaining another modem, such as the TAPR 1200 bps PSK modem, to the same TNC that the 9600 bps modem is attached.

NOTE: In its default condition, all pin pairs of P2 are shorted, e.g., pin 1 to pin 2, pin 3 to pin 4, etc. If an external modem is attached, the default shorting traces on the bottom of the modem PC board must be cut. If any traces are cut, shorting jumpers must be installed at P2 if the additional modem is disconnected.

Pin	Name	Function
1*	DCD In	Data Carrier Detect output from 9600 bps modem. A logic low indicates DCD. This signal must be passed to pin 2 when the attached external modem is not in use.
2*	DCD Out	Data Carrier Detect output from the attached external modem. This pin must reflect the state of pin 1 when the external modem is not in use.
3	N/C	Not connected.
4	N/C	Not used.
5*	RTS Out	Request to Send input to the 9600 bps modem. The signal at this pin must reflect pin 6 when the external modem is not in use.
6*	RTS In	Request to Send input from the TNC to the attached external modem.
7	N/C	Not used. Shorted to pin 8.
8	N/C	Not used. Shorted to pin 7.
9	N/C	Not used. Shorted to pin 10.
10	N/C	Not used. Shorted to pin 9.

11*	TXC Out	Transmit Clock output to TNC. This square wave is at 32x or 16x the data rate. It must be passed to pin 12 when the attached external modem is not in use.
12*	TXC In	Transmit Clock input from TNC. This signal is at 16x or 32x the data rate.
13*	RXC Out	Receive Clock output to TNC. This signal is at 32x or 1x the data rate. It must be passed to pin 14 when the attached external modem is not in use.
14*	RXC In	Receive Clock input from TNC.
15*	GND	Power and signal common.
16	N/C	Not used.
17*	RXD In	Receive Data from the 9600 bps modem to the TNC. This signal must be passed to pin 18 when the attached external modem is not in use.
18*	RXD Out	Receive Data from the attached external modem. This pin must reflect the state of pin 17 when the attached external modem is not in use.
19*	TXD In	Transmit Data from the TNC. This pin should remain shorted to pin 20 at all times.
20*	TXD Out	Transmit Data to the TNC's modem. This pin should always be shorted to pin 19.

ERRATA

Unfortunately, we have discovered a few errors in the board layout for the secondary connector. If you do not plan to use your modem with an external modem connected to P2, you can ignore these, but TAPR recommends that you make the following modifications before building your modem kit if you intend to use it with another modem in the future.

( ) On the top of the 9600 modem board, cut the traces that ties P3 pin 1 to P2 pin 2.

( ) On the top of the 9600 modem board, cut the trace that ties P3 pin 17 to P2 pin 18. This trace passes between RP2 pin 2 and 3 and is difficult to get to.

( ) On the bottom of the 9600 modem board, cut the trace that ties P2 pin 1 to U14 pin 12.

( ) On the bottom of the 9600 modem board, cut the trace that ties P2 pin 17 to U14 pin 19.

( ) On the bottom of the 9600 modem board, add a jumper from U14 pin 12 to P2 pin 2

( ) On the bottom of the 9600 modem board, add a jumper from U14 pin 19 to P2 pin 18.

( ) On the bottom of the 9600 modem board, add a jumper from P3 pin 1 to P2 pin 1.

( ) On the bottom of the 9600 modem board, add a jumper from P3 pin 17 to P2 pin 17.

Example: Attaching a TAPR 1200 bps PSK Modem

If the above pin descriptions look confusing, this section will describe interfacing a TAPR PSK modem to P2.

NOTE: The PacComm PSK Modem attaches in exactly the same manner as the TAPR PSK modem.

( ) Build and test the PSK modem without the 9600 bps modem and verify that it is working as expected.

( ) Build and test the 9600 bps modem and verify that it works as expected.

( ) On the bottom side of the 9600 bps modem PC board, carefully cut the traces shorting P2 pins 1 and 2.

( ) Likewise, cut the trace shorting P2 pins 17 and 18.

( ) Install push-on jumpers at P2 pins 1 and 2 and at P2 pins 17 and 18.

( ) Again verify the correct operation of the 9600 bps modem.

( ) Remove both push-on jumpers at P2.

( ) Install the modem disconnect header from the PSK modem to P2.

That's all there is to it! Now, when you wish to operate 1200 bps PSK packet, you turn on the PSK modem, de-select the 9600 bps modem (short JP6) and operate as if the 9600 bps modem weren't installed. When you wish to operate 9600 bps, switch off the PSK modem and operate as if it weren't there. For normal operation of your TNC, switch off the PSK modem and de-select the 9600 bps modem.

TROUBLESHOOTING

This section of the manual will deal diagnosing and repairing your 9600 bps modem in case it does not operate properly.

Before you attempt to troubleshoot your modem, you should carefully read and understand the **Detailed Circuit Description** section earlier in this manual.

Equipment Needed

You will need an oscilloscope, preferably DC coupled and able to read waveform voltages on the order of 1 to 5 volts with 10% accuracy. Calibrated, triggered sweep is a plus (and probably necessary). Almost any oscilloscope made in the last 15 years will suffice. The highest frequency of interest is a few hundred kilohertz.

A DC voltmeter to verify the 5-volt regulator is also necessary. Any DVM will work, and an old VOM with better than 5% accuracy will substitute easily.

Checking It Out

NOTE: If the signals aren't present as noted in this section, refer to the next section for the expected signal path back to the source.

NOTE: CMOS levels means voltages that swing within 1/2 volt of GND and +5 VDC.

Verify the +5 volt regulator output! If this voltage is out of tolerance (+4.75 to +5.25 volts), find and fix the problem before proceeding!

A TNC is NOT necessary unless you are using the TNC for a power source or a clock source.

Set the CLOCK jumper as appropriate for the TNC you are using.

Verify that there is a 9600 Hz square wave present at U19 pin 4. See "Waveform 2" at the end of this section.

Adjust the deviation control R21 for an amplitude of 1 volt peak-to-peak at U22 pin 7. See "Waveform 1" at the end of this section. This should be a clean-looking waveform with high frequency components of 4.8 kHz. If you see higher-frequency noise on the output (usually around 200 kHz), U22 is oscillating. This may be due to a bad op amp or some sort of feedback from your transmitter input.

Install a jumper at P1 pins 1 and 2. This will loop back the transmit audio signal to the receiver input.

Set control R11 full CCW.

A replica of the transmit waveform from U22 pin 7 should appear at U5 pins 3, 1, 5, 7 and TP1 in that order. See "Waveform 1." The waveform may alter slightly as it passes through this filter, with the higher frequencies becoming attenuated. The DC level of the waveform will be at +5 VDC through the filter.

U4 pin 1 (data slicer output) should have a rectangular waveform of about 5 volts amplitude. Rise and fall times will be in the sub-microsecond range. This waveform is applied to U13 pin 19, delayed, and passed out U13 pin 15 to U7 pin 12 (descrambler input) and U16 pin 2 (state machine data input).

A 16x clock (153.2 kHz) should be present at U16 pin 11. Synchronized to the rising edge of this clock, the slicer data at U16 pin 2 should appear at U16 pin 19 and U15 pin 3. A 9600 Hz clock should appear at U16 pin 15, U7 pin 11 and U19 pin 1. An inverted version of this clock should appear at U19 pin 2, U7 pin 3 and U8 pin 3.

Sliced data at U7 pin 12 should appear at U7 pin 9 synchronized to the rising edge of the clock at U7 pin 11.

Descrambled data out should appear at U11 pin 11 with "glitches" of not more than 150 nSec. The output, free of glitches, should appear at U19 pin 12 (receive data output). The receive data output should match the transmit data input at U9 pin 12, with a time delay and perhaps some jitter.

At this point, the modem is essentially functional. All that remains of its basic operation is the DCD, PTT and TNC interface circuitry.

DCD is derived from U15 pin 19, which will either be near 0 VDC or have regular pulses from near +5 VDC to near 0 VDC. (It will be near +5 VDC when no signal is being received.) This pattern will be inverted and appear at U19 pin 6. A peak detector at the output of U19 pin 6 drives U19 pin 9. The peak detector is also a filter and determines the "attack time" of the DCD circuit. It is designed to provide minimum falsing on noise. The output of U19 pin 8 appears at U12 pin 11. (U12 pin 12 looks for transitions from U7 pin 8 which will indicate that the modem is "hearing" something. This received activity is used to gate the DCD to ensure that DCD is not asserted because of complete silence at the modem input. Remember, the DCD portion of the State Machine is looking for erroneous data transitions -- a lack of incoming data will have no erroneous transitions!) U12 pin 10 will be near + 5 VDC and drive LED D5 ON assuming JP1 is intact. U12 pin 9 will be near 0 VDC. This is the DCD output signal.

PTT is applied to U12 pin 3 as a signal near 0 VDC when the transmit function is activated. U12 pin 6 will go near +5 VDC, turning on Q1 and applying a ground to the PTT output at P1. U12 pin 7 will go near 0 VDC, turning on LED D3. A slowly rising voltage will appear at U12 pin 2. If the transmit key signal is applied to U12 pin 3 for too long, the voltage at U12 pin 2 will rise high enough to timeout U12, removing the PTT from the radio and extinguishing the PTT LED.

The TNC interface circuitry looks a bit complex but is really just a big switch. A written explanation would be long and confusing. The signals are plainly labelled on the schematic. The important points about the interface are:

1) The modem requires a 16x or 32x clock from the TNC or internal clock option.

2) The TNC DCD signal comes in on P3 pin 2 and goes out on P3 pin 1. The 9600 modem passes this signal when it is not selected, and passes its own DCD signal out P3 pin 1 when it is selected. The TNC needs the DCD signal at P3 pin 1; the 9600 modem does not need the TNC signal at P3 pin 2.

3) The TNC RTS (transmit command) signal comes from P3 pin 5. The 9600 modem needs this signal. If the 9600 modem is deselected, it passes P2 pin 5 to P3 pin 6; if it is selected, it passes no signal to P3 pin 6.

4) The 9600 modem expects a 16x or 32x clock from P3 pin 12.

5) RX Data from the TNC comes in at P3 pin 18. This signal is passed to P3 pin 17 if the 9600 modem is deselected; the 9600 decoded data is passed to this pin if the modem is selected.

6) Tx data comes from the TNC at P3 pin 19. This data is passed to P3 pin 20 as well as the 9600 modem at all times.

Where to Look for Missing Signals

9600 Hz Transmit Clock

If the 9600 Hz clock isn't present on U19 pin 4, trace it back to U13 pin 16, then U13 pin 8, then U21 pin 6. See "Waveform 2." If it is still not present, look for a 16x clock (153.6 kHz) at U21 pin 1, then U13 pin 13, then U21 pin 11 OR pin 13 (depends on whether your TNC / clock provides a 16x or 32x clock -- the signal at U21 pin 11 should be 1 / 2 the frequency of the signal at U21 pin 13). If the clock is still not present (whew!), then U14 pin 16 and U13 pin 4 should be checked if you are using the TNC clock, or U14 pins 5 (16x clock) or 6 (32x clock) if using the internal clock option. By this time, I will assume you have the 9600 Hz clock at U19 pin 4...

No Transmit Waveform

Incoming data isn't needed here. Assuming the 9600 Hz clock is present at U19 pin 4, check for it at U9 pin 11, U9 pin 3 and U10 pin 3. See "Waveform 2".

Next, verify that data at CMOS levels appears at U11 pin 3, then at U17 pin 3.

Verify that 9600 Hz appears at U17 pin 5, 19,200 Hz at U17 pin 6, 38,400 Hz at U17 pin 7 and 76,800 Hz at U17 pin 8. Finally, check for 153.6 kHz at U17 pin 9 and U18 pin 11.

Once these signals are present, look for the waveforms labelled A, B, C and D in the transmit analog section. See "Waveform 1". A varying data pattern should be present at U17 pins 11-13 and 15-19, as well as at U18 pins 2 through 9 and pins 13 through 19, and finally at U20 pins 5 through 11. This pattern is stored in EPROM U17 and generated as a result of the clock signals from U21 and the data pattern from U11A.

No Data Slicer Output

Follow the analog signal from P1 pin 1 through U5A and U5B. Verify the DC level of the signal is near +5 VDC. The reference voltage at U4 pin 2 should likewise be +5 VDC, and the same value as the "center" of the signal voltage. The output of the slicer should go from nearly 0 VDC to +5 VDC.

No Receive Clock

The 16x signal at U16 pin 11 is essential. After this signal is verified, check all connections between U15 and U16, and all other connections of U15. If U16 pin 19 does not follow U16 pin 2, U16 is probably bad. If it does and there is still no 9600 Hz output at U16 pin 15, then U15 is likely bad.

No Receive Descrambled Data

Assuming data at U7 pin 12 and clock at U7 pin 11, verify the clock signal at U19 pins 1 and 2, U7 pin 3 and U8 pin 3. If all is well, try substituting the parts in the descrambler (U7, U8, U11 and U19).

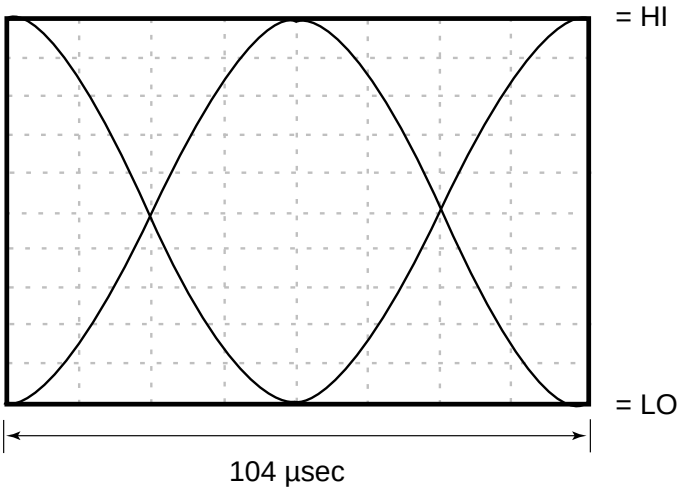
No DCD

If U12 pin 11 is pulled below +0.8 VDC and there are transitions at U12 pin 12, then if no DCD is present U12 is probably bad.

No PTT

Verify the inputs as described. If they are present and there is no output, U12 is likely bad.

Waveform 1



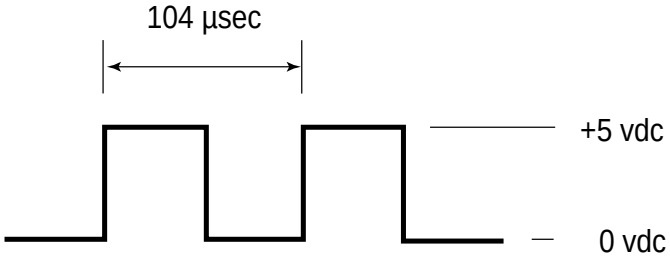
(A) HI = +2.4 VDC, LO = +2.0 VDC, waveform is "stepped"

(B) HI = +6.0 VDC, LO = +4.8 VDC, waveform is "stepped"

(C) HI = +6.0 VDC, LO = +4.8 VDC, waveform is "smooth"

(D) Waveform is variable amplitude up to about 1.5 V peak-peak

Waveform 2



NOTES ON OPTIONS

Clock Option

Use the clock option if you are:

(1) using the modem as a stand alone bit regenerator, or
(2) using the modem with a TNC 1 or TNC 2 or exact clone at "ODD" data rates, or

(3) using the modem with a TNC 2 or other switch-selected radio port data rate TNC and you desire to automatically select the 9600 bps data rate when the 9600 bps modem is selected via JP6.

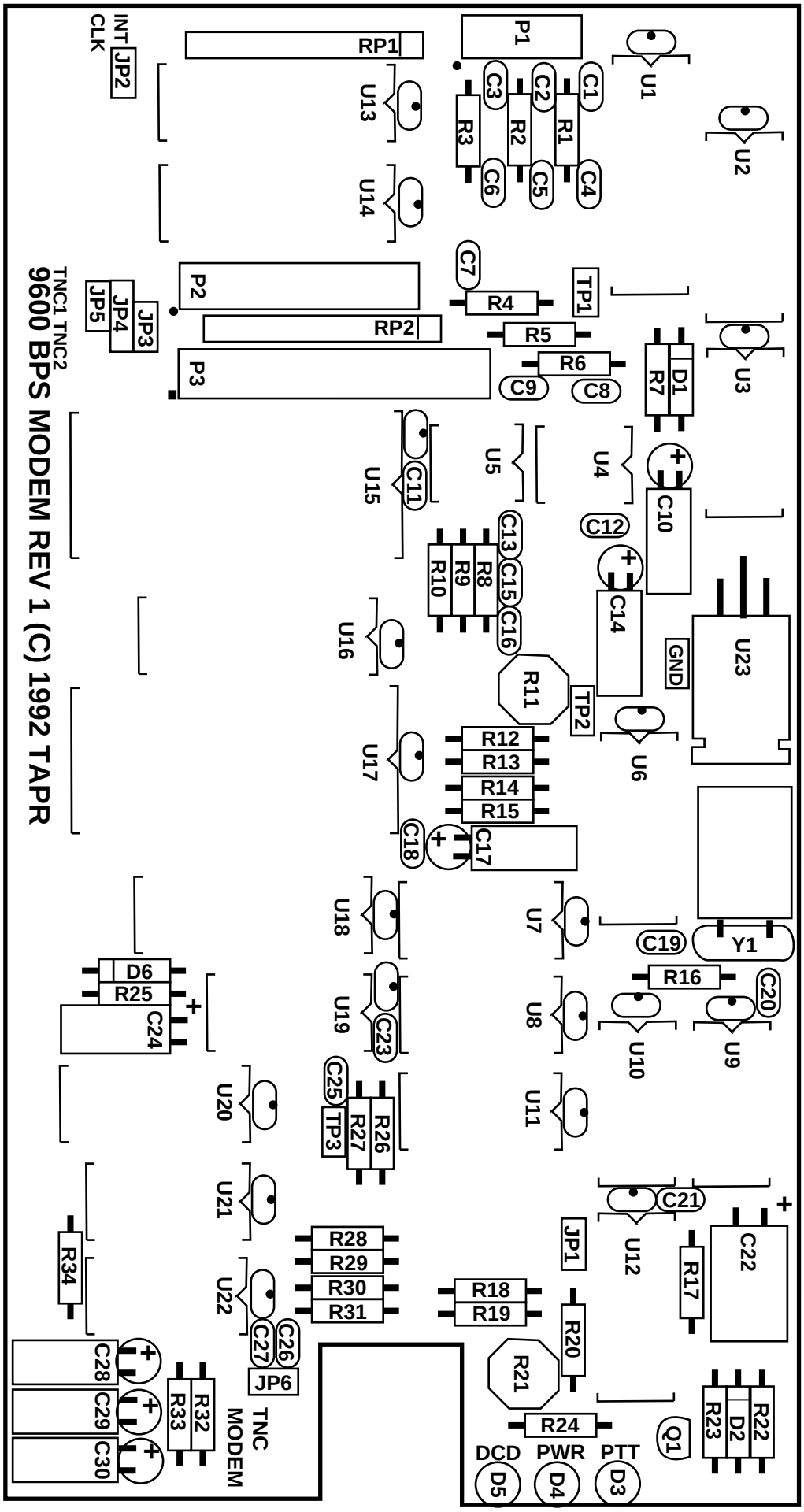
Do **not** use the clock option if you are:

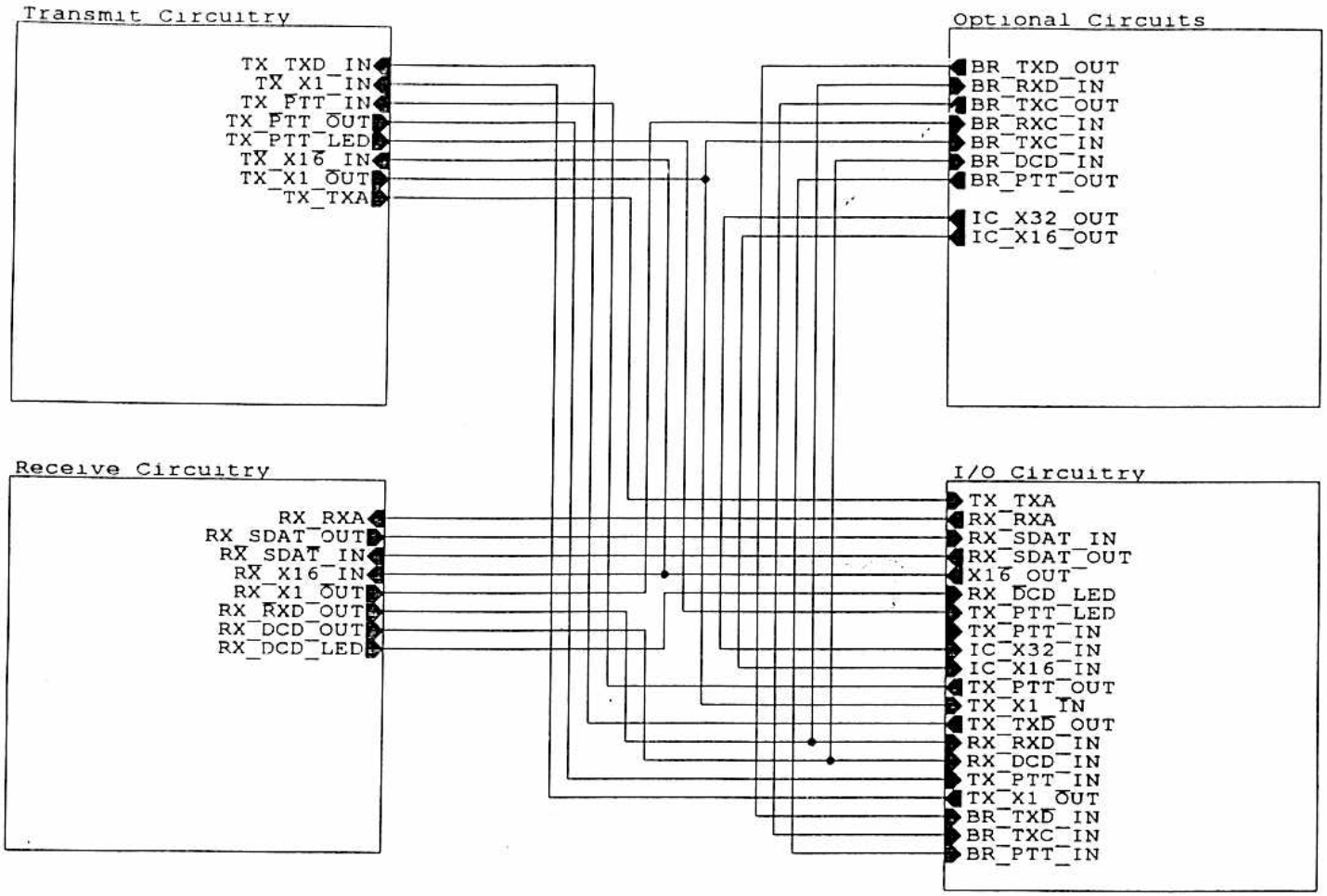
(1) using the modem with a PK88, PK232, DRSI PC*PA or
(2) a TNC which cannot accept an external clock signal.

Bit Regenerator Option

Use the bit regenerator only if you are using the modem as part of a full-duplex repeater.

If you use the bit regenerator option for full duplex with a node attacked, the associated TNC will override the bit regenerator when it asserts PTT.


9600 BPS MODEM REV 1 (C) 1992 TAPR
TNC1 TNC2
INT CLK
JP2
RP1
P1
U1
U2
C1
C2
C3
C4
C5
C6
R1
R2
R3
U13
U14
P2
P3
RP2
JP3
JP4
JP5
C7
R4
R5
R6
C8
C9
TP1
D1
R7
U3
U4
U5
U15
C11
C10
C12
C13
C14
C15
C16
R8
R9
R10
U16
U23
GND
R11
TP2
U6
R12
R13
R14
R15
U17
C17
C18
U18
U7
C19
Y1
R16
C20
U8
U9
U10
D6
R25
C24
U19
C23
C25
TP3
R26
R27
U11
U20
U21
C21
U12
JP1
C22
R17
R28
R29
R30
R31
R18
R19
R20
R21
R24
R34
U22
C26
C27
JP6
C28
C29
C30
R32
R33
TNC MODEM
R22
D2
R23
Q1
DCD
PWR
PTT
D5
D4
D3



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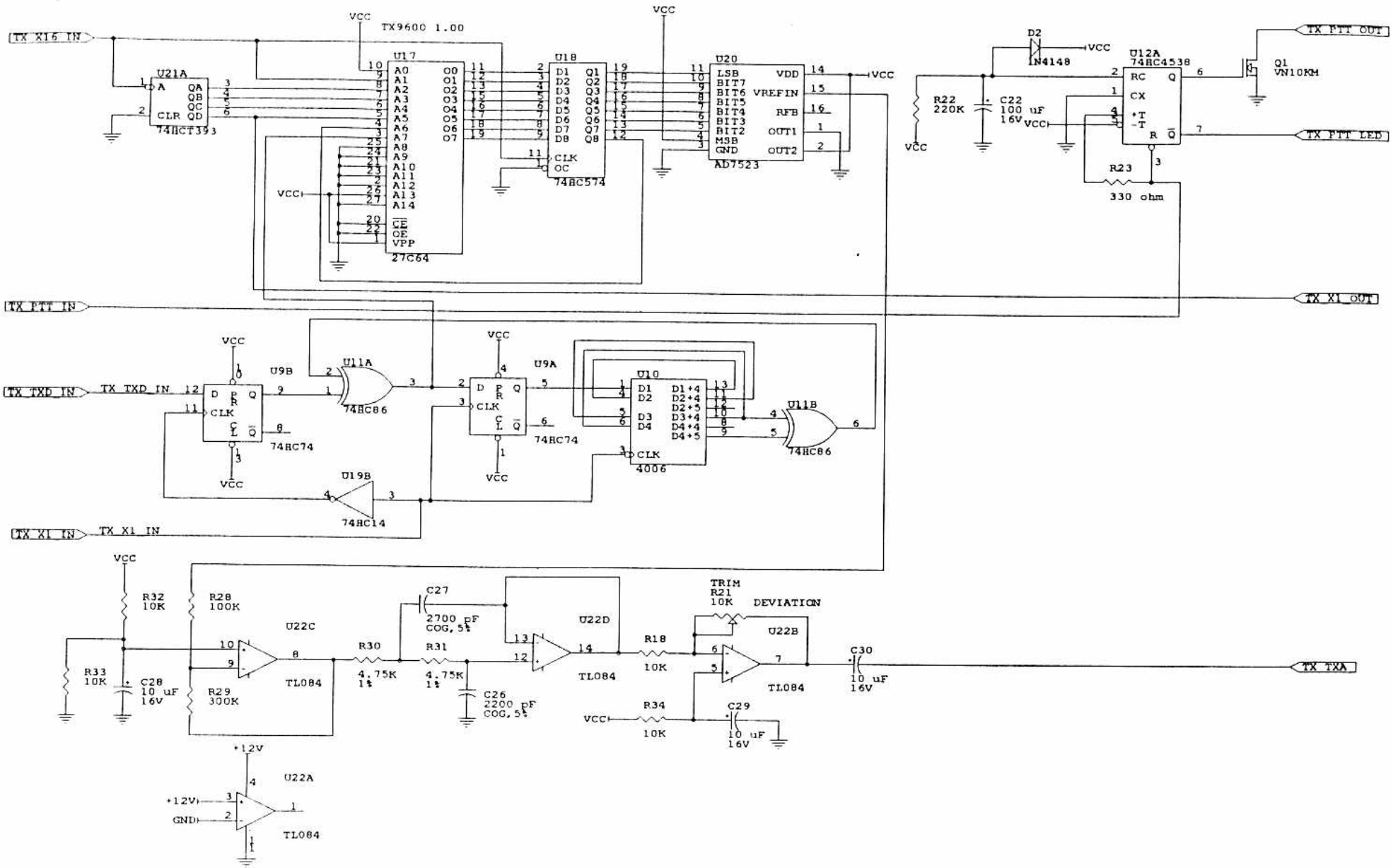
Size: A	Document Number:	REV: 1
Date: June 17, 1992	Sheet 1 of 5	



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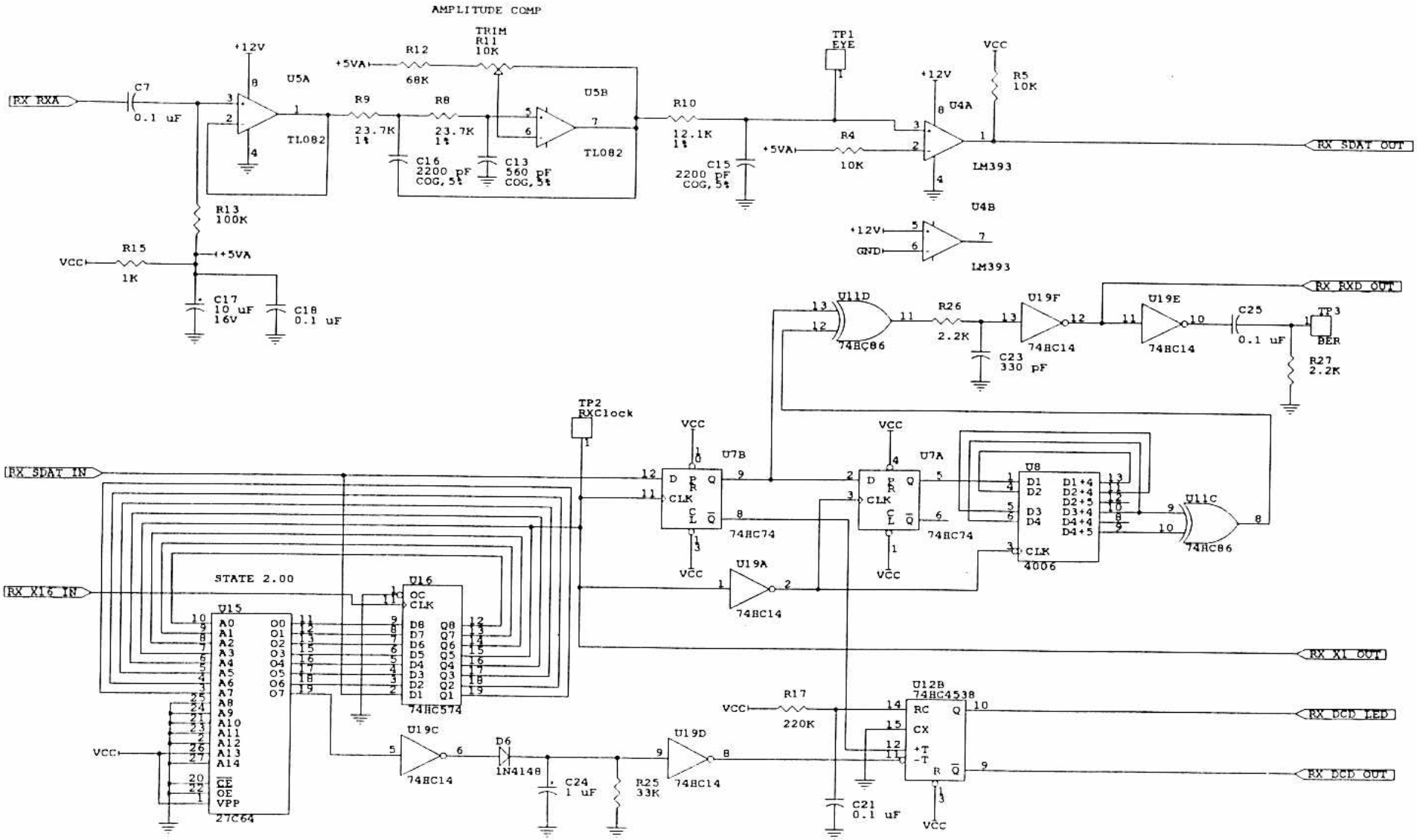
Size B	Document Number 911102	REV 1
Date: June 17, 1992	Sheet 2 of 5	



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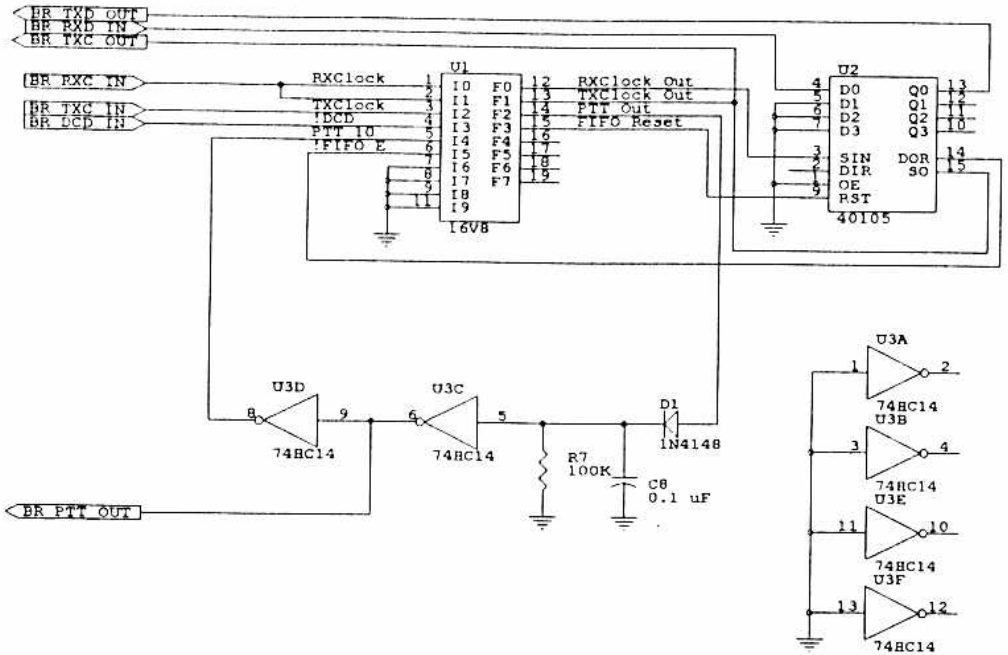
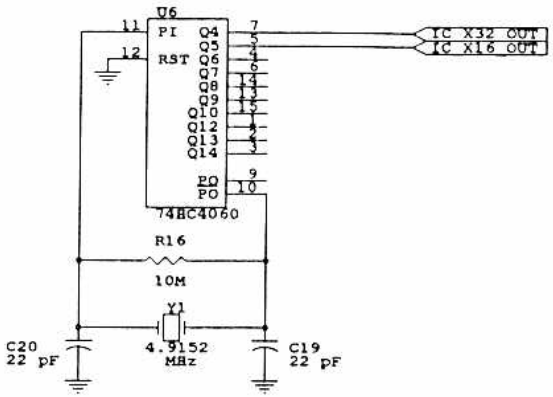
Size: B	Document Number: 911102	REV: 1
Date: September 27, 1992	Sheet 3 of 5	

BIT REGENERATOR



INTERNAL CLOCK



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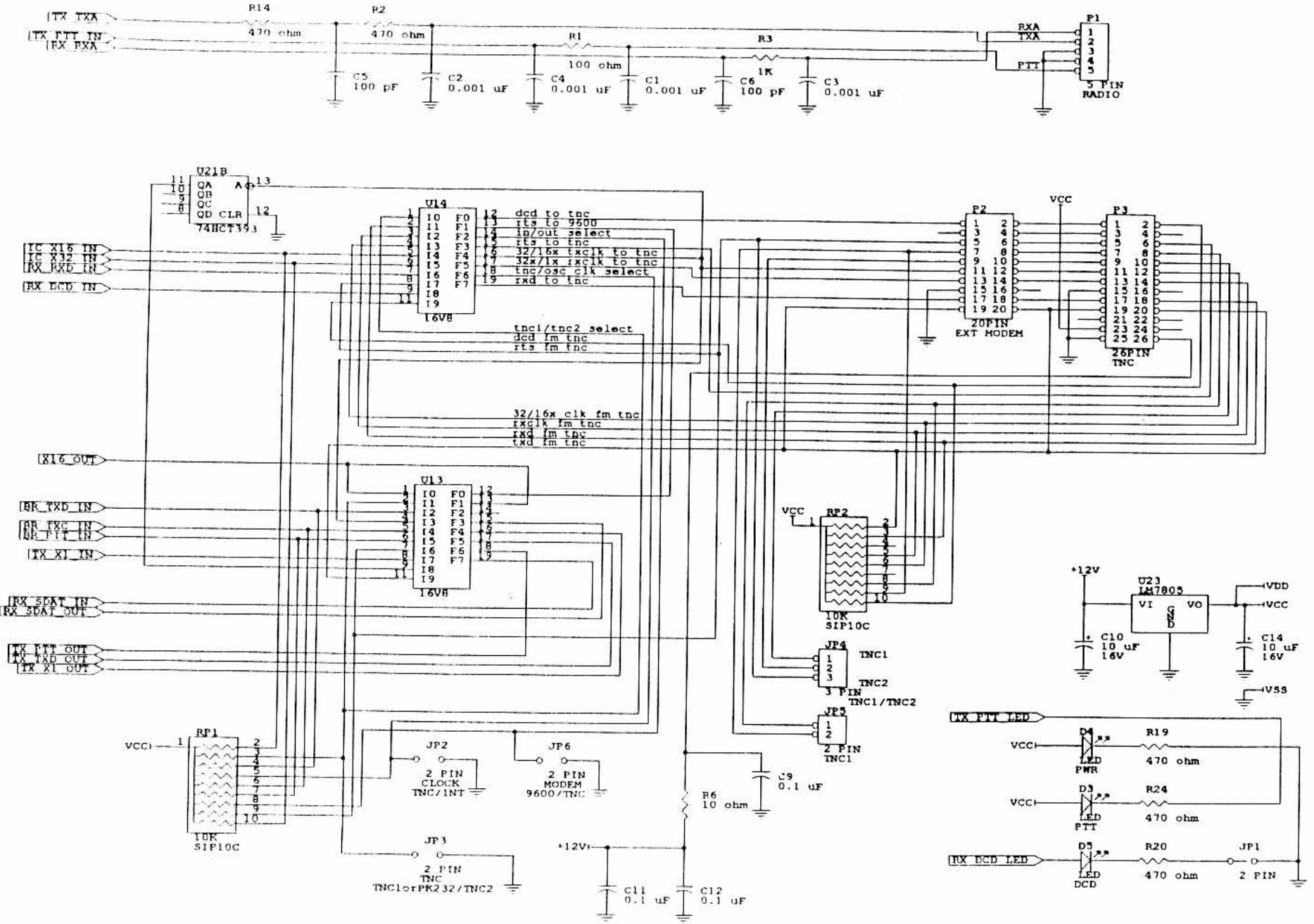
Date: June 17, 1992	Sheet 4 of 5	



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Date: June 17, 1992	Sheet 5 of 5	